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DAILY EDITION

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WE GUARANTEE, that of this issue 7,400 copies were printed; that of those 7,400 copies, 6,120 copies were mailed or delivered by messenger to regular paid subscribers; 997 copies were distributed among members and guests of the American Railway Engineering Association and at the Coliseum; 133 copies were mailed to advertisers; and 150 copies were set aside for office use.

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CONTENTS

An Excellent Report

The convention spent all of yesterday afternoon considering the report of the committee on Economics of Railway Location. No committee of the American Railway Engineering Association has any problems for consideration of greater importance to the railways than that on Economics of Railway Location, and probably no committee has worked harder. However, this committee has had a somewhat checkered career during the past few years and ran true to its previous form this year in submitting majority and minority reports. In the discussion, however, the differences of opinion largely disappeared. The active part of many members took in the discussion yesterday afternoon showed not only their interest in this subject, but their appreciation of the importance of the committee's recommendations. While the chairman and his associates received a considerable grilling from the members on the floor they stood their ground and in most cases were supported by the convention.

The Electrification Discussion

The papers and discussion on the "Operating Results of the Electrification of Steam Railroads" at the meeting of the Western Society of Engineers last night form a valuable addition to the literature on this subject, based as they are very largely on the results secured and expected from the important projects inaugurated so far. Up to this time the advocates of steam railway electrification have advanced claims without being able to offer definite figures in support of their statements. As a result some of these statements have been exaggerated while others have been equally conservative. The interest shown in last evening's meeting by the railway men in attendance at the convention indicates that this subject will receive closer attention in the future than it has in the past because of the existence of statistics such as those presented last night.

Condensing Committee Reports

Although the report of the treasurer showed a surplus of over $3,000 for the past year, the financial problem before the American Railway Engineering Association is a pressing one, especially since the American Railway Association has withdrawn its support to the Rail Committee. There are a number of vitally important investigations which can well be undertaken by this association to the benefit of all the railways. However, it has been impossible to finance any of these special investigations except by contributions from outside sources. It is in this way that the work of the Rail Committee, the investigations of impact and the study of stresses in track have been financed. Practically all of the funds of the association are devoted to their publications, including the bulletins, the annual proceedings and the Manual President Storey called attention to one means of reducing expense in his annual address yesterday morning by the condensation of the committee reports. This is highly desirable, entirely aside from the consideration of the cost of their publication. The reports have grown more voluminous each year, those presented at this convention exceeding in volume those of any previous year. To a considerable extent this is due to the endeavor of many of the committees to include all information incident to the subject under consideration which may be of possible interest to the members. The result is that the reports are so voluminous and contain such a number of replies from various railway men, many of which are either contradictory or a duplication, that the average man does not give the reports the attention they deserve. If the committees would give this large amount of information the attention it deserves and condense it in the reports they would be of greater value to the membership at large. The collection and compilation of the data on any particular subject should be only a portion of the committee work. Equally important is its condensation into the minimum space consistent with the inclusion of all pertinent facts. With 22 separate and independent committees it is very difficult to secure the same degree of condensation. For this reason the suggestion has been made that a special editing committee be appointed to consider all reports and to co-operate with the various committees in the preparation of their reports for publication.

SIGNALING AND THE A. R. E. A. MANUAL

An important question of policy was raised yesterday morning in the discussion of the recommendation of the Committee on Signals and Interlocking that a long list of standards and specifications of the Railway Signal Association be printed in the Manual as information. Active opposition to this move developed on the ground that such an action is not consistent with the rules for the publication of the Manual which provide only for "definitions, specifications and principles of practice that have been made the subject of special study by a committee and which, after due consideration and discussion, have been voted on and formally adopted by the association." The committee, which is composed largely of men who have also been active in the work of the R. S. A., felt that in view of the large volume of matter adopted by that association it would not be practicable to present for consideration by the A. R. E. A. in its convention all of the standards and specifications which may be of value to its members and that the cost of reprinting this matter would be excessive and unwarranted. A number of members favored the acceptance of the committee's recommendation as the only practicable way for the A. R. E. A. to cover the highly technical features of signaling and urged the necessity for co-operating in some such mannner with the organizations representing the various specialized branches of railway engineering and maintenance. It was made clear that no question was being raised as to the value of the work done by the R. S. A. or the interest that this matter would have for members of the A. R. E. A. and most of the argument centered on the question of publishing the list in the Manual or only in the proceedings.

The ease with which material can be located in the Manual and the difficulty connected with a search in the numerous volumes of the proceedings was apparently largely responsible for the final vote to accept the committee's recommendation. While this action may have been justified in this instance, any tendency to adopt specifications in wholesale lots or otherwise to lower the high standards held up for the Manual is to be very carefully guarded against. The specifications and principles of practice contained in the Manual should be such as can be put in practice by the members. The general index of the contents of the annual proceedings which is to be prepared will to some extent remove the objections to putting valuable information needed for frequent reference only in the proceedings. To serve its fullest purpose, this index should be very complete, detailed and cross referenced and in addition should be revised frequently to keep it up to date.

THE SCIENCE OF ORGANIZATION

Following the gradual replacement of the relatively efficient English-speaking track laborer of 20 years ago with the greatly inferior laborer from southern Europe and Mexico, the impression has gradually arisen that the railways can expect to secure only the poorest laborer for this work, and that satisfactory results cannot therefore be expected. Undoubtedly this feeling has contributed largely to the inefficiency of track labor. Because of the large numbers of men employed in track work, relatively little attention is paid to the character of those selected, this being left largely to the labor agents, to whom one man is as good as another.

The cost of maintenance of way is rising rapidly from year to year. A considerable part of this increase is undoubtedly due to the decreasing efficiency of the labor employed. Any means, therefore, which will tend to increase its efficiency is highly important to the railways. For this reason the report of the committee on Rules and Organization on the subject of "Maintenance of Way Organization" is of special interest. Only a start could, of course, be made on a subject as broad as this in one year, and the present report is therefore an abstract discussion of the general principles underlying scientific organization, without special reference to the maintenance of way department. These principles must form the basis of any such a study, and the problem is to properly adapt and apply them to the particular field.

The saying that,

If you think you're beaten, you are.
If you think you dare not, you don't.
If you would like to win, but think you can't,
It's almost a cinch you won't,

is of special application here. Contractors and other employers have been able to convert far more of our foreign laborers into efficient workmen than have the railways. It would seem possible for the railways to do as well as the contractors in this regard, if they would first convince themselves that they can. There is no more important problem confronting the maintenance of way officer, whether he be the chief engineer, supervisor or foreman than that of securing the proper organization to obtain the best results, and all the steps leading to this end are worth the most careful study.

TO-DAY'S PROGRAM

The convention will be called to order at 9:30 this morning. The following reports will be presented:

III.	Ties	Bulletin 173
XV.	Iron and Steel Structures	Bulletin 173
XIII.	Water Service	Bulletin 173
V.	Track	Bulletin 173
VI.	Buildings	Bulletin 173
XVII.	Wood Preservation	Bulletin 174
XIX.	Conservation of Natural Resources	Bulletin 174
Special.	Stresses in Railroad Track	Bulletin 173
	Annual Dinner at 7:00 p. m.	

In addition the Rail report will be presented at 2 o'clock this afternon as a number of the members of the committee will be unable to remain for the sessions Thursday. In addition, the reports of the committees on Roadway and Records and Accounts were held over yesterday afternoon.

BLOCK SIGNAL COMMITTEE OF ELECTRIC RAILWAYS

The joint committee on Block Signals of the American Electric Railway Engineering Association and the American Electric Railway Transportation and Traffic Associations was in session at the Congress hotel yesterday. The principal subjects under discussion were rules, definitions, aspects, standardization and highway crossing protection.

ANNUAL MEETING NATIONAL RAILWAY APPLIANCES ASSOCIATION

The annual meeting of the National Railway Appliances Association was held yesterday morning at the Coliseum. A motion was made and carried dispensing with the reading of the minutes of the last meeting, but during the discussion of the question it was brought to the attention of the administration that it was quite desirable especially for out-of-town members who did not have easy access to the secretary's office, to receive a printed report.

President Hench in his address called attention to the advantage of confining the exhibit this year to the Coliseum. All the space was rented, all collections have been made and there is a small waiting list of concerns desiring to exhibit. Last year there were 160 members, as compared with 140 this year.

Treasurer Kelly reported that this year the association would probably show a profit of a little over $700.

A rising vote of thanks was given the retiring adminis-

tration and F. R. Wyles, retiring director, for the very efficient work done in the face of unfavorable conditions. The following officers were elected for the ensuing term:

President, Philip W. Moore, P. & M. Co.; vice-president, H. M. Sperry, General Railway Signal Co.; treasurer, C. W. Kelly, Kelly-Derby Co.

Directors: Three years—P. C. Jacobs, H. W. Johns-Manville Co.; R. C. McCloy, Wm. Wharton, Jr., & Co., Inc.

THE PAST AND THE FUTURE KING SNIPE

A DAY WITH JERRY, THE KING-SNIPE OF TWENTY YEARS AGO.

Run the car out of the house, byes,
And set her on the thrack;
Put on the picks and linin' bars
And don't forget the jack.

We've six long miles to pump her, byes,
Before the stroke of seven,
For I want yez all to be at work
When the Boss goes East on 'Leven.

So heavy on the lever, byes,
Come on, me hearts of oak,
Whilst I set on the water keg
And watch ahead for smoke.

Let yez set the car off here, byes,
And unload all the tools.
We'll raise the jints and tamp the ties
Accordin' to the rules.

Now pull the bad ties out, byes,
And, Paddy, take the jack.
Raise the jint ahead a notch
And then the center back.

Tamp all thim ties up snug, byes,
And spike thim right to gauge.
Then dress the ballast to the line,
For neatness is the rage.

Let's put the car on now, byes,
'Tis just the stroke of six.
Load up the jacks and water keg,
The level board and picks.

Now heavy on the lever, byes,
And let her roll to town.
Pick up the slow flag as we pass
So the Mail need not slow down.

Roll the hand car in the house, byes,
And lock the door up tight.
Be here early in the mornin'
'Twas a good day's work—Good-night.

A DAY WITH TONY, THE KING-SNIPE OF THE FUTURE.

Come on, every bod', it's time-a to go!
My watch-a say seven o'clock.
Push-a da gas car on-a da track
And watch if we get-a da block.

What! No gas'line in-a da tank?
Angelo, tak-a da can
And get-a some at da dippo, quick.
From da big-a Agent man.

We gotta plenty time, you know,
To fix-a up da track
So sit-a down here on da car
Till Angelo com-a back.

Ah! here he com-a, now fill-a da tank
And lock-a da car-house, Joe.
Com-a here in front and turn-a da crank
Dat's fine—Away we go.

Here is da place, take off-a da tools
And set off da big gas car
No tak-a da picks—too hard on da back—
Just use-a da tamping bar.

Tree or four you fellas tak-a da car,
Bring some hot macarone from da town.
Be sure and stay in da pass-a track
When da fast Passenger go down.

Too hot-a out here, I go to da shade.
Pietro, you raise-a da track.
Set-a da spot board two inch or so—
At four o'clock I com-a back.

Now I feel-a good, let's dress-a da rock
And line-a da track up swell.
What! Brought-a no lin-a bars out today?
Well, tomorra just as well.

Hurry up, you fellas, it's half past five,
And verra hungry I feel.
We gotta be at da camp at six
To getta da good hot-a meal.

M. E. Carroll.

A BIG CONTRACT

The Cumberland Valley will close bids to-day at the office of T. B. Kennedy, engineer, Chambersburg, Pa., for the construction of a double-track concrete arch bridge 4,000 ft. long across the Susquehanna river at Harrisburg, Pa. The structure will consist of 45 spans, each approximately 75 ft. long, on foundations built by the railway last year. This will require the placing of 56,000 yd. of concrete. It is desired that the first half of this structure having one track be completed this year. Over 40 bids have been received.

CHANGES ON THE B. & O.

W. H. Averell, assistant general superintendent of the Baltimore & Ohio at New York, N. Y., has been appointed general superintendent, succeeding U. B. Williams, whose headquarters have been at Wheeling, W. Va. Mr. Williams has been appointed general agent.

SPOKANE TRACK ELEVATION WORK

The Northern Pacific started work last week on the elevation of about two miles of line in Spokane, Wash. The roadbed is from 85 to 225 ft. wide and will be raised 12 to 16 ft. on a fill between retaining walls. The concrete in the retaining walls and abutments for about 20 street bridges is being placed by the McMichael pneumatic mixing and placing process, the contractor for this work being the Pacific Concrete Placing Company. One machine mounted on a flat car is now being used and another soon will be mounted to push the work. The cars on which the pneumatic mixers are mounted carry bins for the concrete aggregate, which are filled from gondola cars by locomotive cranes with clam shell buckets. The work is being handled under the direction of W. L. Darling, chief engineer, the general contractor being The W. J. Hoy Company, St. Paul, Minn. The concrete mixing and placing apparatus is leased by The Concrete Mixing & Placing Company, Chicago.

Proceedings of Railway Engineering Association

Abstracts of Five Reports Including Rules and Organization, Signals and Economics of Railway Location

The Sixteenth Annual Convention of the American Railway Engineering Association opened at 9:35 a. m. on Tuesday, March 16, in the Florentine Room, Congress Hotel, Chicago. W. B. Storey, Jr., vice-president, Atchison, Topeka & Santa Fe, was in the chair. The minutes of the last annual meeting were approved.

PRESIDENT'S ADDRESS

Your Association during the past year has continued the work so well planned by the founders of the organization. The Committees have worked with interest and zeal; reports have increased in volume, and as an indication of

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W. B. STOREY, JR., President.

the interest being taken we find a tendency toward the publication of more and more data, all of it interesting.

The year that has passed has been one of stress in railway circles. The credit of the roads being impaired, money has been hard to borrow, and as a consequence the building of new lines has been curtailed and improvement of old ones has been impossible. This in turn has affected the general business of the country, and, with other causes not pertinent for discussion here, has made hard times, diminishing in turn the revenues of the roads and making economies necessary in every direction, and in many cases more than economies, viz., the postponement of work that must eventually be done in order to keep the roads up to the requisite standard.

The usefulness of your Association would be increased if we had more funds. We would, if we had it, spend money on many lines of investigation with profit to our profession, with credit to our organization and to the advantage of the railway interests of this country. The Association, however, has been compelled to restrict its work to the publication of reports by its Committees except in cases where we have had outside help. We should publish a General Index, and it is the purpose of the Board to undertake this at an early date. It is true that we have accumulated something of a surplus, but the publication of a new edition of the Manual, together with the Index, will make large inroads on this surplus within the next year or two.

About the only way in which the reeeipts of the organization can be increased is by increasing membership. While we have been growing steadily and consistently, it is suggested that a special effort should be made to bring into our Association all those in the railroad world eligible to membership. Many railway men feel that the work of the Association does not directly interest them and that they will not be gainers by holding membership. Possibly this class could be reached by pointing out to them that we need their help, and that they should join in order to assist in the improvement of the railroad profession. We have in the past year taken in 137 new members. The hard times have somewhat increased the total of deductions from these additions, so that the total gain is 89.

As stated above, the work of your Association has been confined to publications except where we have had outside help. We have had this in the matter of the impact tests, which were undertaken a number of years ago, and more recently in our rail investigations. The American Railway Association has been bearing the expense of this work. Unfortunately for this work that Association has now withdrawn its support, and your Association is confronted with the necessity of stopping the work so well begun, and it is felt that the full benefit of the work already accomplished will be lost unless some arrangement can be made to carry it forward. We, as engineers, recognize that any improvement, no matter how small, in the matter of steel rails will justify any expenditure that has been or may be made, but the difficulty confronting us is convincing our operating people of this. The Executive Committee of the American Railway Association is charged with the responsibility of the expenditure of money, and its action has been taken because we have not convinced it that the expenditure pays. Possibly if we made individual effort with our operating superiors we might bring about a unanimity of action on the subject that, communicated to the Executive Committee, would change its present attitude, and it is requested that the members of your Association will do what they can in this direction.

There is one further subject to which the efforts of the individual members of the Association might be called, viz., the Fiscal Year. The Track Committee has recommended that it be changed and made coincident with the calendar year. It is true that some roads at the present time use this method of division. The majority of the roads, however, and the Interstate Commerce Commission make the fiscal year from July 1 to June 30. A search for reasons for this division has disclosed that it is largely a matter of custom. To change it, however, will be difficult owing to the necessity for changing the by-laws of practically all the roads in the country, together with dates of annual meetings. While the Interstate Commerce Commission has specified this particular division, it is felt that it did so for the sake of uniformity and because the greater part of the mileage of the country used it. The objections from a track maintenance point of view are very strong. Under the present method we are unable to plan intelligently the work for an entire season, which at its best is but short, and under present conditions work must often be abandoned after being begun, or possibly cannot be started until after the beginning of the new Fiscal Year. To make the change will take time and continued effort, but it is felt that our membership might accomplish much toward this end.

An inspection of the reports submitted for this convention will show an unusual amount of statistical data, principally tabulations of replies received by the respective Committees in response to inquiries. It is believed that if your Committees would give certain attention to condensing this data and showing same graphically, a very marked saving might be effected by diminishing the amount

of our printing and the value of the information increased to those who have occasion to use it.

Probably your most important publication is the Manual, in that it embodies the principles which have been adopted as representing standard railway practice in this country. These vary, and must of necessity do so or there would be no progress. It is the intention, therefore, to republish the Manual as soon as possible after the convention, and

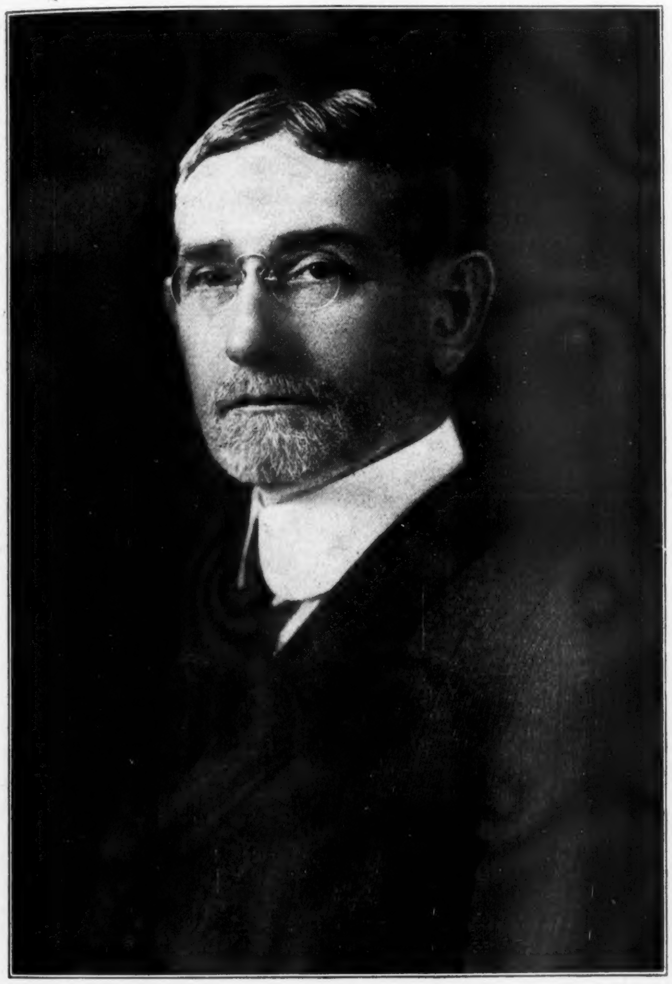


Photo by Matzene, Chicago.

ROBERT TRIMBLE, First Vice-President.

it will contain the approved recommendations for the past sixteen years, and it may be said, without contradiction, that this volume will exemplify the best present practice for railway engineering and maintenance of way work.

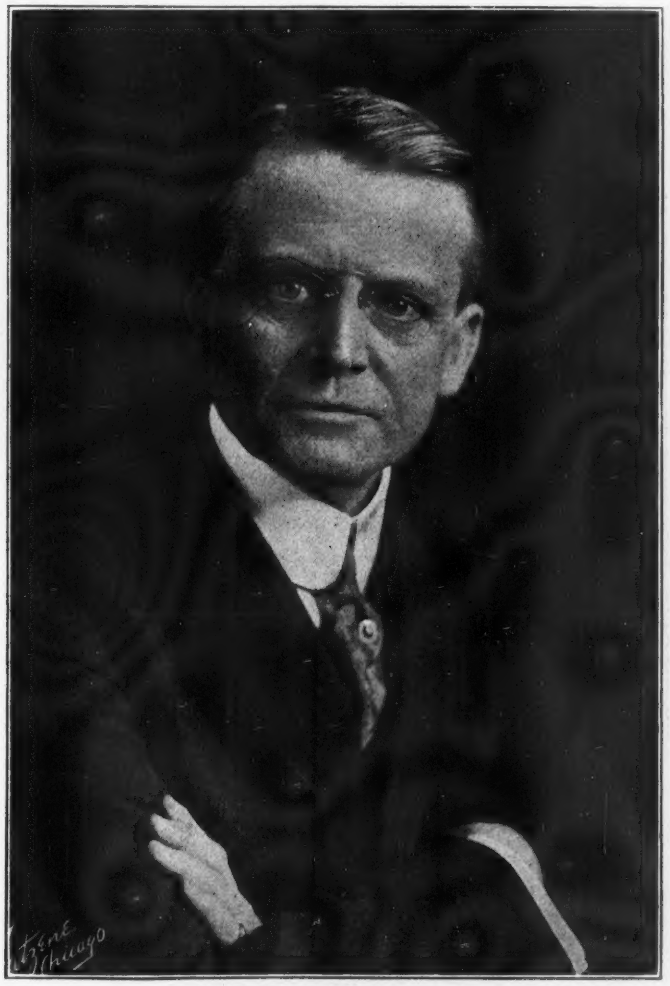
While your work, as stated above, is circumscribed by lack of funds necessary for special research, the financial condition of the Association, due to the lines which have been followed, is gratifying, there being in the Treasury at the close of the last calendar year over $17,000. The cost of republishing the Manual and the proposed General Index will reduce this, it is estimated, by about $7,000. It is to be hoped that the members of the Association will use every endeavor to increase the sale of publications.

It may be said that the European War is hardly one for consideration by a body of this kind, but the catastrophe is so great, and its influences will be so widespread, that it is of paramount interest even to an organization like ours. Railroad transportation has played a very important part in its prosecution. The mobilization of vast armies, greater than any before gathered together, and this in an incredibly short time, is solely due to the railroad facilities. It may be said that the transportation problem is one of the great features of the war, and the men who are handling this are as responsible for the success of their side as the generals in command.

Financial conditions have very seriously affected all railway and engineering construction during the past year, and as a consequence there is lacking the usual long list of notable achievements. One event stands out prominently, viz., the opening of the Panama Canal, which is so directly allied to our character of endeavor. This is now introducing economic features in the country's transportation problem which may have a farreaching effect, possibly changing a large element of the transportation of the country from rail to shipping, and incidentally raising questions of economical handling of freight at docks and wharves, and the attention of our members interested in this class of work is called to this fact. At the present time the overland roads are feeling seriously the inroads on the business formerly carried by them, and as the shipping interests are enlarged the subject may be of even greater importance.

The valuation of railways under the Interstate Commerce Commission has begun in earnest. Parties have been and are at work in all parts of the country, and on some of the roads the work has progressed so far that the quantities are nearly complete. The principles to be followed are being worked out gradually, but there is still much to be determined. Our entire membership should be vitally interested in this work, involving, as it does, not only the actual measurement of earth work, but the more intricate determination of the face of the country before any construction was begun; the establishing of unit prices that include elements not used when the work was originally built, such as transportation; the fixing of land values, and, finally, questions of depreciation not only in the roadway and structures, but in equipment. All of these matters demand our earnest consideration, and as was pointed out by your President last year, your Association should lead in the study and consideration of the questions involved.

One of the small results of the European war in this country has been the curtailment of our supply of creosote from Germany, and this in turn has necessitated changing



A. S. BALDWIN, Second Vice-President.

the methods of treatment of our ties. We could, of course, in time meet this by the manufacture of creosote in our own country, but manufacturers are hardly justified in undertaking this, as immediately on the cessation of the war we can look forward to the resumption of the low-priced German product. Some of us have substituted chloride of zinc, and others are putting in ties without treatment.

Reports of Secretary and Treasurer

Balance, cash on hand, December 31, 1913		$14,276.74
Consisting of:		
Cash in bank	$ 5,066.41	
Six railway bonds, par value $1,000 each, at cost	5,206.06	
Four Lincoln Park bonds, par value $1,000 each, at cost	4,004.27	
Total	$14,276.74	
Receipts during the year 1914:		
From members	7,901.00	
From publications	15,594.19	
From interest on bank balance	115.94	
From interest on investments	400.00	
From. Am. Ry. Assn.—(Rail Committee Expenses)	6,650.13	
Miscellaneous	1,585.99	
Total receipts in 1914	$32,247.25	
Expenditures during 1914	29,211.72	
Excess of receipts over expenditures	$ 3,035.53	3,035.53
Balance on hand, December 31, 1914		$17,312.27
Consisting of:		
Six railway bonds, par value $1,000 each, at cost	$ 5,206.06	
Four Lincoln Park bonds, par value $1,000 each, at cost	4,004.27	
Cash in Standard Trust and Savings Bank	8,101.94	
	$17,312.27	

RULES AND ORGANIZATION

The committee on Rules and Organization worked during the past year under the following instructions:

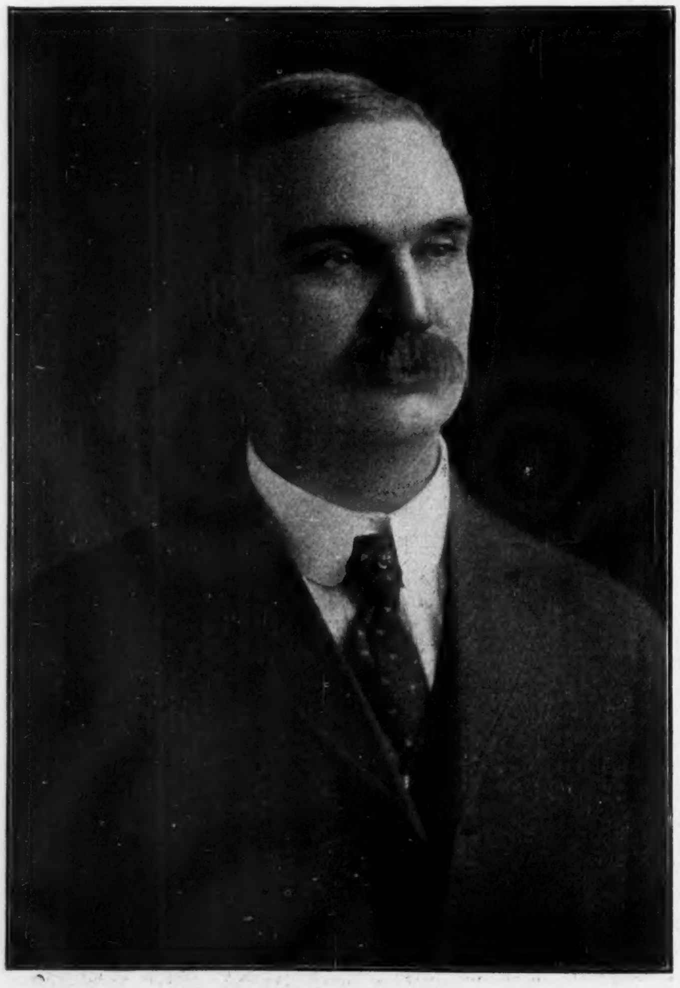
(1) Review rules and instructions heretofore adopted by the Association and recommend such changes and additions thereto as may seem desirable. (Not reported on.)

(a) Formulate rules for the guidance of the maintenance of way department pertaining to safety.

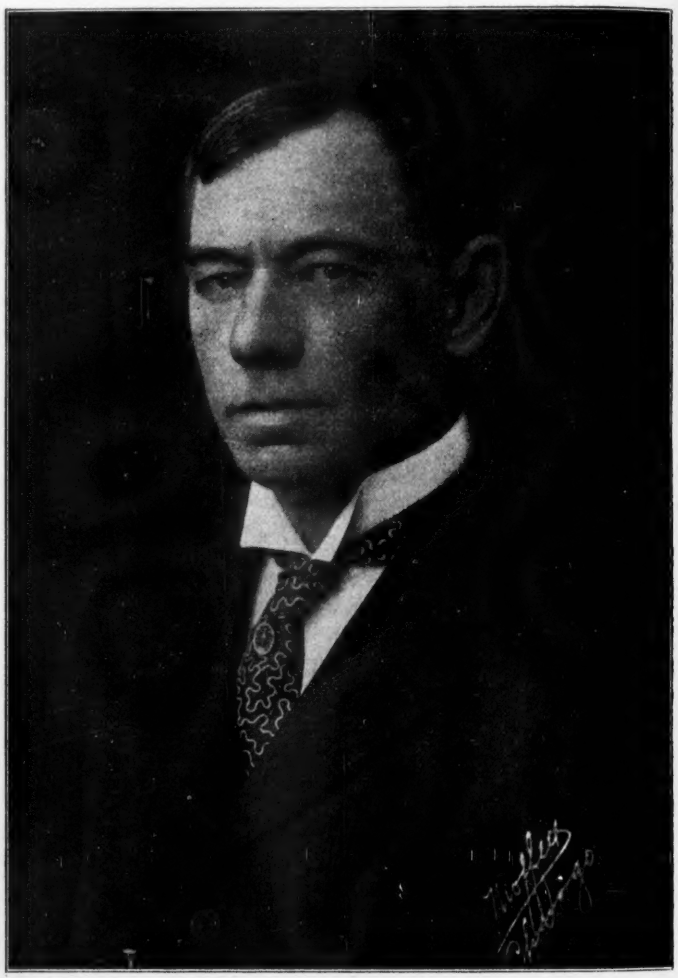
(3) Continue the formulation of rules for the guidance of field parties: (Not reported on.)

(a) When making preliminary surveys.

(b) When making location surveys.



G. H. BREMNER, Treasurer.



E. H. FRITCH, Secretary.

(c) When in charge of construction.

(4) Continue the study of science of organization.

SAFETY RULES.

The following safety rules are recommended for adoption and printing in the Manual:

(1) It is the duty of every employe working on or about the tracks to exercise great care to avoid injury to himself and others, and nothing in these rules is to be so construed as to relieve any employe from performing his full duty in that respect.

(2) Employes must examine and know for themselves that tools, materials, etc., which they must make use of in performing their duties are in proper condition. If not, they must put them so, or report them to the proper person and have them put in proper order before using.

(3) In handling rails, ties and other heavy materials, special care must be used to avoid injury.

(4) On the approach of a train, employes who are working on or about the tracks must move to places of safety, standing clear of all running tracks. They must not walk or stand on the tracks, except when necessary for the proper performance of their duties.

(5) Watchmen, patrolmen, trackwalkers and others on duty which makes it necessary for them to be on the track, where there are two or more tracks, should, when practicable, travel against the current of traffic, keeping a sharp lookout in both directors for approaching trains.

(6) Foremen or others in charge of employes must see that their men are alert and watchful to avoid danger, and when working on or about the tracks they will take the

CONVENTION OF THE AMERICAN RAILWAY ENGINEERING ASSOCIATION IN SESSION.

necessary precautions to see that all men working under their immediate supervision receive warning of approaching trains in time to reach places of safety.

(7) When working on tracks in places where approaching trains cannot readily be seen because of permanent obstructions to the view, curves, or temporary obstructions, such, for instance, as fog, storms, snow, or engines or cars, extra precautions must be taken to warn the men of approaching trains. Foreman, watchmen, and others in charge of gangs or squads of workmen should provide themselves with whistles or other means for warning the men when working in places where approaching trains cannot readily be seen.

(8) When large numbers of inexperienced men are working on the track, they should be divided into small squads, each squad placed in charge of an experienced man, and all necessary additional precautions taken to prevent accident.

(9) Employes working in or near the ends of tunnels must clear all tracks when trains approach from either direction, and if in the tunnel, must occupy the manholes.

(10) In tunnels and in other places where there is insufficient clearance and no manholes or other places of safety provided, foremen must arrange with the proper officer for the use of the track and work under flag protection.

G. D. BROOKE,
Chairman Committee on Rules and Organization.

(11) Employes are required to carry lanterns or torches when passing through any tunnel where men cannot readily be seen. When an entire gang is working close together in a tunnel, an adequate number of lights should be used, but not less than two.

(12) Hand or push cars must not be used at night, nor in the daytime when approaching trains cannot readily be seen by reason of fog, storm or snow, except under proper protection.

(13) Trains will be run in either direction, on any track, whenever necessary or expedient, and employes will be governed accordingly.

(14) Employes will keep the right-of-way, and particularly the main, yard and sidetracks and the footpaths along them, free of obstacles, such as old material, broken draw-bars, lumps of coal, and anything over which they or others may stumble.

(15) Any employe, who is careless about the safety of himself or others while on duty, or who disregards warnings, will be disciplined.

SCIENCE OF ORGANIZATION.

The committee's work on this subject has consisted in collecting some additional data in regard to the forms of organization of the maintenance of way department in use on the various railroads, and the internal workings of these various organizations. An attempt to assemble data bearing on the historical aspect of the development of the present maintenance of way organizations has not met with much success, but further efforts will be made along this line. It is desirable to draw attention to the fact that several of the great railroad systems are making successful experiments in selecting and training men for positions in the maintenance of way department, and there is undoubtedly a growing tendency in favor of the systematic developing of men to supervise maintenance of way forces.

NEXT YEAR'S WORK.

The following outline of work for next year is recommended:

(1) Review rules and instructions heretofore adopted by the Association and recommend such changes and additions thereto as may seem desirable.

(2) Continue the formulation of rules for the guidance of field parties.

(a) When making preliminary surveys.

(b) When making location surveys.

(c) When in charge of construction.

(3) Continue the study of the science of organization.

(4) Report on the clearance of switchstands, signal stands, platforms, platform shelters, mail cranes, water columns, coal chutes, water tanks, etc., under the assignment from the Committee on Maintenance of the American Railway Association.

G. D. Brooke (B. & O. S. W.), chairman; F. D. Anthony (D. & H.), vice-chairman; R. P. Black (K. & M.), L. L. Beal (A. B. & A.), Ralph Budd (G. N.), A. M. Burt (N. P.), J. B. Carothers (B. & O. S. W.), S. E. Coombs (N. Y. C.), Curtis Dougherty (Q. & C.), B. Herman (Southern), Jos. Mullen (C. C. C. & St. L), E. T. Reisler (L. V.), Committee.

APPENDIX A.

Report to Board of Direction on the Study of the Science of Organization.

The committee on Rules and Organization was instructed, in addition to other work, to "Begin the study of science of organization and report to the board of direction how this study can be made profitable to the Association."

Organization is the direction of the efforts of a number of individuals to a common purpose. In the commonly accepted use of the term, an organization is a collection of individuals, or groups of individuals, acting under a central control, by means of which their efforts are directed to a common purpose.

The science of organization is the systematized knowledge pertaining to, or the acknowledged laws, as demonstrated by observation or deduction, relating to the direction of the efforts of groups or individuals to common ends.

In its workings, the individual is the prototype of the organization. Every physical act of the human animal requires three distinct processes of effort in its performance: (1) The knowledge of an existing reason for or the self-impelled desire for the act. This is mental effort. (2) The instruction to the hand, eye, or other physical member to perform and how to perform. This is also a mental process. (3) The execution by the physical member. This is physical effort.

Consider next a small group of men as a unit for the performance of work, as a squad of soldiers or a section gang. A leader or foreman is necessary, who is the mind or brain of the unit; the other men are the physical agencies. (1) The leader possesses the knowledge of or conceives of what is to be done. (2) He communicates to the men what is to be done and how it is to be done. (3) The men perform the work.

Continuing the analogy, the logical development is the company of soldiers and the force under a supervisor; the regiment and the track forces of a division; the brigade and the forces of a district; the army corps and the maintenance of way department of a railroad system. Each successive unit is made up of a number of smaller units; each larger unit is under the control of a head who conceives or plans the work, and conveys his instructions as to what is to be done; the constituent units receive the directions and execute the work. The efficiency of any unit depends upon the ability of the leader in planning work or devising action to meet varying situations; his method of transmitting the instructions to the constituent units, since this determines with what degree of clearness his ideas and plans are understood; and the spirit and the degree of preparedness of the constituent units in receiving and executing the instructions.

There are certain fundamental principles of organization which may be classified, as: The proper selection of material; Compensation; Education; *Esprit de Corps;* and discipline.

The athlete in training is required to conform to rigid rules of diet and habits. In practice and during contests he must obey in letter and spirit the instructions of coach or manager. Failure to comply with rules and instructions will result in the offender being dropped from the team or

subjected to other penalty. In military service the infraction of regulations or disobedience of instructions are penalized by fines, confinement, hard labor or dismissal from the service according to the circumstances and the nature of the offense.

The maintenance of way organizations of the railroads of this country have been developed by the force of attendant circumstances rather than along preconceived or well-studied plans; this was particularly true prior to a decade ago, but is still true to a large extent. Nevertheless, it has on the whole fulfilled its object admirably and has risen to the heights which each successive occasion has demanded. Within the past few years the realization of the importance of a well-balanced organization has been growing and considerable thought and attention have been devoted to bettering existing organizations in some quarters, with good results, so far as they have gone.

A study of the maintenance of way organization to determine to what extent each of the five principles above enumerated has been applied, is being applied, and can be applied; if some of them are being applied to the undue exclusion of others; and the best means of effecting a proper balance of them in any further development that may be undertaken, will constitute a study of the science of organization as applied to the maintenance of way department.

The committee has started the collection of data as to the maintenance of way organizations of the various railroads, represented in the Association, and proposes to make use of the information gathered by the committee on Track and other committees in connection with the studies of economics of track and other labor.

An example of what can be accomplished by thorough instruction is found in the method of the signal maintenance forces of one trunk line. Monthly meetings are held by the signal engineer, which all assistant engineers, signal supervisors and signal inspectors are required to attend. Materials, methods and proposed instructions are discussed fully and the minutes of the meetings distributed in printed pamphlets to all interested. In this way the best ideas are secured, the reasons for adopting standard practices in methods or materials are fully understood, and all minds are freed of any possible prejudice towards them. And when circulars putting standard practices into effect are issued, there is the assurance that they are interpreted uniformly over the entire system. The excellent results obtaind in a very few years are a splendid justification of the application of scientific organization.

Benefits from Study.

As illustrating the present-day tendency to devote more serious thought to the question of organization, attention is directed to the splendid paper on "Development of Young Men in Railroad Work," by George M. Basford, read before the New England Railroad Club on January 13, 1914, and the discussion which followed (see *Railway Age Gazette*, January 16, 1914). While dealing primarily with the needs of the mechanical department Mr. Basford brings out forcibly the application of the ideas to the other departments.

Discussion on Rules and Organization

The report was presented by Curtis Dougherty by paragraphs, and adopted, the committee being excused.

SIGNALS AND INTERLOCKING

The committee was instructed to continue the study of Economics of Labor in Signal Maintenance, to formulate and present requisites for switch indicators, to present for approval specifications which had been previously adopted by the Railway Signal Association and which the committee considered would warrant consideration, and to study the problem of signaling single-track roads with reference to the effect of signaling and proper location of passing sidings on the capacity of the line.

The committee presented an amplification of the adjunct in the standard code and requisites for switch indicators which has been adopted by the Railway Signal Association.

SWITCH INDICATORS.

(C) Indicators at main track switches to indicate, on roads of two or more tracks, one or more of the following: (a) Whether or not a train is approaching; (b) whether or not that portion of the block between the switch and the next home block signal in advance is clear; (c) whether or not the next home block signal in the direction of approaching trains is at stop.

REQUISITES OF INSTALLATION.

(1) Switch indicators, if practicable, located: (a) At main track switches connecting with tracks on which trains may clear main tracks, and in which either there are no derails or diverging switches, or the derails or diverging switches are connected with the main track switches; (b) at independently operated derails or diverging switches in tracks on which trains may clear main tracks; (c) at points from which switches of crossovers between main tracks are operated, where both switches are operated from the same point; (d) at independently operated switches of crossovers between main tracks, the indicator at the switch in one track operated in connection with the other track; (2) switch indicators that cannot be identified by their locations, marked with the designations of the tracks in connection with which they are operated.

(3) The connections of switch indicators used to indicate whether or not a train is approaching, so arranged that an indicator will indicate the approach of a train that has reached a point at least such a distance in the rear of the second block signal in the direction of approaching trains that if the switch is thrown at the moment when a train reaches

T. S. STEVENS,
Chairman Committee on Signals and Interlocking.

that point the caution signal will be displayed in time to be observed by the engineman and will continue so to indicate until the train passes the home block signal in the rear of the switch, or approximately, the clearance point of the switch when the switch is more than .... feet in advance of the home block signal. The distance of the point at which the approach of a train is first indicated will be determined in each case by the grade, speed of trains, view of the signal or other local conditions.

It was recommended that the amplification of these recommendations for switch indicators be adopted and included in the next issue of the Manual.

The committee gave subject 3—Specifications of the Railway Signal Association Which in the Judgment of the Committee Warrant Consideration by the American Railway Engineering Association—careful study and presented a list of specifications and standards which represent 654 pages of printed matter. All of this has been very carefully considered by committees and adopted by the active and representative membership of the Railway Signal Association. They are being used extensively and therefore are standards of many railroads as well as the R. S. A. As all of this material is available in the Manual of the Railway Signal Association and because of the large expense involved in reproducing it, it was suggested by the committee that a list only of specifications and standards be included in the Manual of the A. R. E. A., and for reference as to details any member could consult the Proceedings or Manual of the Railway Signal Association.

RATING OF OPERATED UNITS

The committee presented a table of operated units and points assigned to each unit as a revision of the Table of Units now included in the Manual. This was thought necessary because the present table does not take many electrical

units into consideration and is therefore incomplete. The table presented not only brings the original table up to date in so far as the operated units are concerned, but assigns points to each unit which are more in accordance with the actual cost than does the present table. This table appeared in the *Daily Railway Age Gazette* of March 16 as Table A under the report of the committee of the Railway Signal Association on Contracts.

AUTOMATIC TRAIN CONTROL.

The committee presented as information the findings of the joint committee of the American Railway Association on the subject of Automatic Control of Trains. These requisites were published on page 1192 of the *Railway Age Gazette*, May 29, 1914.

REVISION OF MANUAL.

The committee recommended that the section on Conventional Signs be omitted from the manual having been superseded by the Conventional Signs adopted in 1914, volume XV, pages 81 to 92. Arrangements of Signals and Interlocking Plants has been superseded by the report adopted in 1913, and published in Volume IV, pages 71 to 75. Specifications for Mineral Matter, Rubber Compound, Insulated Wire and Cable have been materially revised by the Railway Signal Association, and are available in the Manual of the R. S. A., and the committee therefore recommended that these be omitted from the Manual of the A. R. E. A.

The committee consists of Thomas S. Stevens, chairman; C. C. Anthony, vice-chairman; Azel Ames (Kerite Co.), H. S. Balliet (G. C. T.), J. B. Cameron (B. & O.), W. B. Causey, C. A. Christofferson (N. P.), C. E. Denney (U. S. & S. Co.), C. A. Dunham (G. N.), W. J. Eck (Southern), W. H. Elliott (N. Y. C.), G. E. Ellis (K. C. T.), M. H. Hovey (Consl. Engr.), A. S. Ingalls (L. S. & M. S.), A. M. Keppell (W. T.), J. C. Mock (M. C.), F. P. Patenall (B. & O.), J. A. Peabody (C. & N. W.), D. W. Richards (N. & W.), A. H. Rudd (Penn.), W. B. Scott (S. P.), A. G. Shaver (Hallett Iron Works).

Discussion on Signal and Interlocking

The report was presented by T. S. Stevens.

Mr. Stevens: On subject 3 the committee presents a list of specifications of the Railway Signal Association. It is suggested that this Association should publish, in its literature, preferably in its Manual, this list of the specifications which have been approved by the Railway Signal Association, and as these have been approved not only by the individual members, but by the representative vote of the Railway Signal Association, it would seem that they are worthy of endorsement by this Association.

The President: The Committee having made the recommendation to include this in the Manual, the matter will be handled as a motion on the part of the committee, to adopt this conclusion. Is there a second to that motion?

(The motion was seconded.)

L. C. Fritch (Can. Nor.): It seems to me that we look upon our Manual as containing Recommended Principles of Practice. This is simply a matter of information. It may fall into the hands of some of our legal friends, and they may take this as absolutely agreed upon, and that these specifications have been approved, and if any of us should have an action involving signals, it might put us in bad shape. It seems to me that as long as it is information simply, it will serve the purpose if it is in our proceedings. If we adopt the specifications, it will then go into the Manual.

Mr. Stevens: There is a broader question than that involved. These specifications are practically the specifications of a large majority of the railroads of the country to-day. They have been tried and approved, at least those that Committee X thought were worthy of being endorsed by the Association. We feel that they would be given more dignity if this Association would agree to place the list in the Manual. The Railway Signal Association has spent four or five years getting them out, and it seems to me that, to be of value, it would be proper that this Association should put them in a convenient place for its membership to find them.

G. H. Tinker (N. Y. C. & St. L.): I agree with Mr. Fritch. This is too much of a wholesale approval of the work of an Association. The only matters which should be put into the Manual are those which have been considered in detail and adopted by the Association.

A. S. Baldwin (I. C.): The declination to include this list in our Manual does not in the slightest degree reflect on the value of this work to the members of this Association. The point we make is that what goes into the Manual should first be passed on and discussed at a meeting of the Association, whereas, if these matters were to be put into our Manual it would be taking in one bunch a whole mass of specifications and data which has not been submitted to the discussion of the members of this Association.

Hunter McDonald (N. C. & St. L.): I inquire in what manner Mr. Baldwin and Mr. Fritch expect to perfect our Manual, in so far as signals are concerned? Do they expect our Committee X to go back and work over this matter with the Signal Association, or do we expect finally to treat the Signal Association as a committee of this Association and endorse their findings?

Earl Stimson (B. & O.): I am in favor of the motion made by the committee. As I understand it, every member of this committee is also a member of the Signal Association. It cannot be expected that this one committee will do the work of probably a dozen committees in the Signal Association, and we certainly should have confidence enough in the Signal Association, through our old members on this committee, to endorse their findings.

Mr. Fritch: I will answer Mr. Stimson by saying that we do not object to accepting the recommendations of the R. S. A., but we do not want to incorporate in our Manual something which is submitted as a matter of information. To my mind, all these recommendations, before they are finally passed by this Association, should go before the American Railway Association, as that is the parent Association, and these matters are of sufficient importance to submit to them. We are following that practice with regard to rail specifications and other matters, and I do not see why we should not with regard to any matter which involves operation as the signal rules and specifications do. In my opinion, it is beyond the power of this Association to pass upon such a matter.

E. H. Lee (C. & W. I.): The committee is asking for the endorsement of these specifications in turns. Some of the speakers have intimated that if our Association gives this endorsement it will have done so without mature consideration. Our Signal Committee is composed of the best brains in the Association along that line, who have devoted several years to the study of this question. They have had the assistance of a great body of men who are intimately acquainted with the subject, who have devoted years to the consideration of this particular subject, which is highly technical and involved. It would seem exceedingly difficult to consider a subject of this kind in any other way than as recommended by the committee.

(After further discussion the suggestion of the committee was adopted, together with the suggestions of the revision of the Manual.)

UNIFORM GENERAL CONTRACT FORMS

The committee was instructed to make a critical examination of the subject-matter in the Manual and submit

E. H. LEE,
Chairman Committee on Uniform General Contract Forms.

definite recommendations for changes, and to continue the study of general forms, including the form of bond.

At the first meeting of the committee a form of bond was agreed upon, which has been unanimously approved by

the members of the committee, and it is presented to the Association with the recommendation that it be adopted.

The members of the Association were invited by circular letter to inform the committee whether they were making use of the uniform general contract form, and also to make such criticisms and suggestions as they might deem pertinent. The response to this letter was very gratifying, nearly 100 letters having been received. About one-third of the replies indicated that the writers were using the uniform general contract form, the remainder, including many from representatives of the larger railroad companies, preferring their own general form of contract, as was, perhaps, to be expected. The general tenor of letters received, however, indicates that the form has served a useful purpos, either directly or indirectly.

At the last two meetings of the committee the form printed in the Manual was carefully considered, and certain changes were agreed upon, which are:

E. H. Lee (C. & W. I.), chairman; C. A. Wilson (Cons. Eng.), vice-chairman; C. Frank Allen (Mass. Inst. of Tech.), W. G. Atwood (Interstate Commerce Commission), John P. Congdon (Cons. Engr.), Thos. Earle (Pa. Steel Co.), J. C. Irwin (B. & A.), R. G. Kenly (M. & St. L.), C. A. Paquette (C. C. C. & St. L.), J. H. Roach (L. S. & M. S.), Committee.

AGREEMENT FORM.

THIS AGREEMENT, made this .... day of .... in the year .... by and between .... party of the first part, hereinafter called the Contractor, and .... party of the second part, hereinafter called the Company:

WITNESSETH, That, in consideration of the covenants and agreements hereinafter mentioned, to be performed by the parties hereto, and of the payments hereinafter agreed to be made, it is mutually agreed as follows:

The Contractor shall furnish all materials, superintendence, labor, equipment and transportation, except as hereinafter specified, and shall execute, construct and finish, in an expeditious, substantial and workmanlike manner, to the satisfaction and acceptance of the chief engineer of the Company, ...

....

in accordance with the plans hereto attached identified by the signatures of the parties hereto, or herein described, and the following GENERAL CONDITIONS, requirements and specifications, forming part of this contract

The work covered by this contract shall be commenced ....

and be completed on or before the........................ .... day of ....191.... time being of the essence of this contract ....

And in consideration of the completion of the work described herein, and the fulfillment of all stipulations of this agreement to the satisfaction and acceptance of the chief engineer of the Company, the said Company shall pay, or cause to be paid, to said Contractor, the amount due to the Contractor, based on the following prices:

....

CONSTRUCTION CONTRACT.

General Conditions.

1. *Bond.*—The Contractor agrees, at the time of the execution and delivery of this contract and before the taking effect of the same, to furnish and deliver to the Company a good and sufficient bond of indemnity to the amount of .... dollars, as security for the faithful performance, by the Contractor, of all the covenants and agreements on the part of the Contractor contained in this contract. The security in such bond of indemnity must be satisfactory and acceptable to the Company.

This bond shall remain in force and effect in such amount, not greater than that specified, as shall be determined by the Chief Engineer.

2. *Contractor's Understanding.*—It is understood and agreed that the Contractor has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and all other matters which can in any way affect the work under this contract. No verbal agreement or conversation with any officer, agent or employe of the Company, either before or after the execution of this contract, shall affect or modify any of the terms or obligations herein contained.

3. *Intent of Plans and Specifications.*—All work that may be called for in the specifications and not shown on the plans, or shown on the plans and not called for in the specifications, shall be executed and furnished by the Contractor as if described in both these ways; and should any work or material be required which is not denoted in the specifications or plans, either directly or indirectly, but which is nevertheless necessary for the proper carrying out of the intent thereof, the Contractor is to understand the same to be implied and required, and shall perform all such work and furnish any such material as fully as if they were particularly delineated or described.

4. *Permits.*—Permits of a temporary nature necessary for the prosecution of the work shall be secured by the Contractor. Permits for permanent structures or permanent changes in existing facilities shall be secured by the Company.

5. *Protection.*—Whenever the local conditions, laws or ordinances require, the Contractor shall furnish and maintain, at his own cost and expense, necessary passageways, guard fences and lights and such other facilities and means of protection as may be required.

6. *Rights of Various Interests.*—Wherever work being done by Company forces or by other contractors is contiguous to work covered by this contract, the respective rights of the various interests involved shall be established by the engineer, to secure the completion of the various portions of the work in general harmony.

7. *Consent to Transfer.*—The Contractor shall not let or transfer this contract or any part thereof (except for the delivery of material) without the consent of the chief engineer, given in writing. Such consent does not release or relieve the Contractor from any of his obligations and liabilities under the contract.

8. *Superintendence.*—The Contractor shall constantly superintend all the work embraced in this contract, in person or by a duly authorized manager acceptable to the Company.

9. *Timely Demand for Points and Instructions.*—The Contractor shall not proceed until he has made timely demand upon the engineer for, and has received from him, such points and instructions as may be necessary as the work progresses. The work shall be done in strict conformity with such points and instructions.

10. *Report Errors and Discrepancies.*—If the Contractor, in the course of the work, finds any discrepancy between the plans and the physical conditions of the locality or any errors or omissions in plans or in the layout as given by said points and instructions, it shall be his duty to immediately inform the engineer, in writing, and the engineer shall promptly verify the same. Any work done after such discovery, until authorized, will be done at the Contractor's risk.

11. *Preservation of Stakes.*—The Contractor must carefully preserve bench marks, reference points and stakes, and in case of wilfull or careless destruction, he will be charged with the resulting expense and shall be responsible for any mistakes that may be caused by their unnecessary loss or disturbance.

12. *Inspection.*—All work and material shall be at all times open to the inspection, acceptance or rejection of the engineer or his duly authorized representative. The Contractor shall provide reasonable and necessary facilities for such inspection.

13. *Defective Work or Material.*—Any omissions or failure on the part of the engineer to disapprove or reject any work or material shall not be construed to be an acceptance of any defective work or material. The Contractor shall remove, at his own expense, any work or material condemned by the engineer, and shall rebuild and replace the same without extra charge, and in default thereof the same may be done by the Company at the Contractor's expense, or, in case the chief engineer should not consider the deflect of sufficient importance to require the Contractor to rebuild or replace any imperfect work or material, he shall have power, and is hereby authorized, to make an equitable deduction from the stipulated price.

14. *Insurance.*—The Contractor shall secure, in the name of the Company and for its benefit, policies of fire insurance on such structures and in such amounts as shall be specified by the chief engineer, not exceeding ....

15. *Indemnity.*—The Contractor shall indemnify and save harmless the Company from and against all losses and all claims, demands, payments, suits, actions, recoveries and judgments of every nature and description brought or recovered against it, by reason of any act or omission of the said Contractor, his agents or employes, in the execution of the

work or in consequence of any negligence or carelessness in guarding the same.

16. *Settlement for Wages.*—Whenever, in the opinion of the chief engineer, it may be necessary for the progress of the work to secure to any of the employes engaged on the work under this contract any wages which may then be due them, the Company is hereby authorized to pay said employes the amount due them or any lesser amount, and the amount so paid them, as shown by their receipts, shall be deducted from any moneys that may be or become payable to said Contractor.

17. *Liens.*—If at any time there shall be evidence of any lien or claim for which the Company might become liable, and which is chargeable to the Contractor, the Company shall have the right to retain out of any payment then due or thereafter to become due, an amount sufficient to completely indemnify the Company against such lien or claim, and if such lien or claim be valid, the Company may pay and discharge the same and deduct the amount so paid from any moneys which may be or become due and payable to the Contractor.

18. *Work Adjacent to Railroad.*—Wherever the work embraced in this contract is near the tracks, structures or buildings of this Company or of other railroads, the Contractor shall use proper care and vigilance to avoid injury to persons or property. The work must be so conducted as not to interfere with the movement of trains or other operations of the railroad; or, if in any case such interference be necessary, the Contractor shall not proceed until he has first obtained specific authority and directions therefor from the proper designated officer of the Company and has the approval of the engineer.

19. *Risk.*—The work under this contract in every respect shall be at the risk of the Contractor until finished and accepted, except damage or injury caused directly by Company's agents or employes.

20. *Order and Discipline.*—The Contractor shall at all times enforce strict discipline and good order among his employes, and any employe of the Contractor who shall appear to be incompetent, disorderly or intemperate, or in any other way disqualified for or unfaithful to the work entrusted to him, shall be discharged immediately on the request of the engineer, and he shall not again be employed on the work without the engineer's written consent.

21. *Contractor Not to Hire Company's Employes.*—The Contractor shall not employ or hire any of the Company's employes without the permission of the engineer.

22. *Intoxicating Liquors Prohibited.*—The contractor, in so far as his authority extends, shall not permit the sale, distribution or use of any intoxicating liquors upon or adjacent to the work, or allow any such to be brought upon, to or near the line of the railway of the Company.

23. *Cleaning Up.*—The Contractor shall, as directed by the engineer, remove from the Company's property and from all public and private property, at his own expense, all temporary structures, rubbish and waste materials resulting from his operations.

24. *Engineer and Chief Engineer Defined.*—Wherever in this contract the word engineer is used, it shall be understood as referring to the chief engineer of the Company, acting personally or through an assistant duly authorized in writing for such act by the chief engineer, and wherever the words chief engineer are used it shall be understood as referring to the chief engineer in person, and not to any assistant engineer.

25. *Power of Engineer.*—The engineer shall have power to reject or condemn all work or material which does not conform to this contract; to direct the application of forces to any portion of the work which, in his judgment, requires it; to order the force increased or diminished, and to decide questions which arise between the parties relative to the execution of the work.

26. *Adjustment of Dispute.*—All questions or controversies which may arise between the Contractor and the Company, under or in reference to this contract, shall be subject to the decision of the chief engineer, and his decision shall be final and conclusive upon both parties.

27. *Order of Completion; Use of Completed Portions.*—The Contractor shall complete any portion or portions of the work in such order of time as the engineer may require. The Company shall have the right to take possession of and use any completed or partially completed portions of the work, notwithstanding the time for completing the entire work or such portions may not have expired; but such taking possession and use shall not be deemed an acceptance of the work so taken or used, or any part thereof. If such prior use increases the cost of or delays the work, the Contractor will be entitled to such extra compensation, or extension of time, or both, as the chief engineer may determine.

28. *Changes.*—The Company shall have the right to make any changes that may be hereafter determnied upon, in the nature or dimensions of the work, either before or after its commencement, and such changes shall in no way affect or void the obligations of this contract. If such changes make any change in the cost of the work, an equitable adjustment shall be made by the chief engineer to cover the same.

29. *Extra Work.*—No bill or claim for extra work or material shall be allowed or paid unless the doing of such extra work or the furnishing of such extra material shall have been authorized in writing by the.................. ....engineer.

The price for such work shall be determined by the chief engineer, who may either fix a unit price or a lump-sum price, or may, if he so elects, provide that the price shall be determined by the actual cost, to which shall be added .... per cent to cover general expense and superintendence, profits, contingencies, use of tools, Contractor's risk and liability. If the Contractor shall perform any work or furnish any material which is not provided for in this contract, or which was not authorized in writing by the engineer, said Contractor shall receive no compensation for such work or material so furnished, and does hereby release and discharge the Company from any liability therefor.

If the Contractor shall proceed with such extra work or the furnishing of such extra material after receiving the written authority therefor, as hereinbefore provided, then such work or material, stated in the written authority of the engineer, shall be covered, governed and controlled by all the terms and provisions of this contract, subject to such prices as may be agreed upon or fixed by the chief engineer.

If the Contractor shall decline or fail to perform such work or furnish such extra material as authorized by the engineer in writing, as aforesaid, the Company may then arrange for the performance of the work in any manner it may see fit, the same as if this contract had not been executed, and the Contractor shall not interfere with such performance of the work.

30. *Property and Right of Entry.*—The Company shall provide the lands upon which the work under this contract is to be done, except that the Contractor shall provide land required for the erection of temporary construction facilities and storage of his material, together with right of access to the same.

The Contractor shall not ship any material or equipment until he has received written notice from the engineer that he may proceed with said work or any part thereof.

31. *Unavoidable Delays; Extension of Time on Parts of Work.*—If the Contractor shall be delayed in the performance of the work from any cause for which the Company is responsible, he shall, upon written application to the chief engineer at the time of such delay, be granted such extension of time as the chief engineer shall deem equitable and just.

32. *Suspension of Work.*—The Company may at any time stop the work, or any part thereof, by giving .... days' notice to the Contractor in writing. The work shall be resumed by the Contractor in ten (10) days after the date fixed in the written notice from the Company to the Contractor so to do. The Company shall not be held liable for any damages or anticipated profits on account of the work being stopped, or for any work done during the interval of suspension. It will, however, pay the Contractor for expense of men and teams necessarily retained during the interval of suspension, provided the Contractor can show that it was not reasonably practicable to move these men and teams to other points at which they could have been employed. The Company will further pay the Contractor for time necessarily lost during such suspension at the rate of .... per cent per annum on the estimated value of materials, equipment and fixtures furnished by the Contractor on the work which are nenessarily idle during such suspension, said rate of .... per cent per annum being understood to include depreciation, interest and insurance. But if the work, or any part thereof, shall be stopped by the notice in writing aforesaid, and if the Company does not give notice in writing to the Contractor to resume work at a date within .... of the date fixed in the written notice to suspend, then the Contractor may abandon that portion of the work so suspended and he will be entitled to the estimates and payments for such work so abandoned, as provided in Section 38 of this contract.

33. (a) *Expediting Work, Correcting Imperfections.*—If the

chief engineer of the Company shall at any time be of the opinion that the Contractor is neglecting to remedy any imperfections in the work, or is not progressing with the work as fast as necessary to insure its completion within the time and as required by the contract, or is otherwise violating any of the provisions of this contract, said *chief* engineer, in behalf of the Company, shall have the power, and it shall be his duty to notify the Contractor to remedy such imperfections, proceed more rapidly with said work, or otherwise comply with the provisions of this contract.

(b) *Annulment.*—The Company, if not at fault, may give the Contractor ten (10) days' written notice, and at the end of that time if the Contractor continues to neglect the work, the Company may provide labor and materials and deduct the cost from any money due the Contractor under this agreement; and may terminate the employment of the Contractor under this agreement and take possession of the premises and of all materials, tools and appliances thereon, and employ such forces as may be necessary to finish the work. In such case the Contractor shall receive no further payment until the work shall be finished, when, if the unpaid balance that would be due under this contract exceeds the cost to the Company of finishing the work, such excess shall be paid to the Contractor; but if such cost exceeds such unpaid balance, the Contractor shall pay the difference to the Company.

(c) *Company May Do Part of Work.*—Upon failure of the Contractor to comply with any notice given in accordance with the provisions hereof, the Company shall have the alternative right, instead of assuming charge of the entire work, to place additional forces, tools, equipment and materials on parts of the work for the purpose of carrying on such parts of the work, and the cost incurred by the Company in carrying on such parts of the work shall be payable by the Contractor, and such work shall be deemed to be carried on by the Company on account of the Contractor, and the Contractor shall be allowed therefor the contract price. The Company may retain the amount of the cost of such work, with .... per cent added, from any sum or sums due or to become due the Contractor under this agreement.

34. (a) *Annulment Without Fault of Contractor.*—The Company shall have the right at any time, for reasons which appear good to it, to annual this contract upon giving 30 days' notice in writing to the Contractor, in which event the Contractor shall be entitled to the full amount of the estimate for the work done by him under the terms and conditions of this contract up to the time of such annulment, including the retained percentage. The Contractor shall be reimbursed by the Company for such expenditures as in the judgment of the chief engineer are not otherwise compensated for, and as are required in preparing for and moving to and from the work; the intent being that an equitable settlement shall be made with the Contractor.

(b) *Notice—How Served.*—Any notice to be given by the Company to the Contractor under this contract shall be deemed to be served if the same be delivered to the man in charge of any office used by the Contractor, or to his foreman or agent at or near the work, or deposited in the postoffice, postpaid, addressed to the Contractor at his last known place of business.

(c) *Removal of Equipment.*—In case of annulment of this contract before completion from any cause whatever, the Contractor, if notified to do so by the Company, shall promptly remove any part or all of his equipment and supplies from the property of the Company, failing which the Company shall have the right to remove such equipment and supplies at the expense of the Contractor.

35. *Failure to Make Payments.*—Failure by the Company to make payments at the times provided in this agreement shall give the Contractor the right to suspend work until payment is made, or at his option, after 30 days' notice in writing, should the Company continue to default, to terminate this contract and recover the price of all work done and materials provided and all damages sustained. and such failure to make payments at the times provided shall be a bar to any claim by the Company against the Contractor for delay in completion of the work, due to such suspension or failure to pay.

36. *Monthly Estimate.*—So long as the work herein contracted for is prosecuted in accordance with the provisions of this contract, and with such progress as may be satisfactory to the chief engineer, the said chief engineer will on or about the first day of each month make an approximate estimate of the proportionate value of the work done and of material furnished or delivered upon the Company's property at the site of the work, up to and including the last day of the previous month. The amount of said estimate, after deducting .... per cent and all previous payments, shall be due and payable to the Contractor at the office of the Treasurer of the Company on or about the .... day of the current month.

37. *Acceptance.*—The work shall be inspected for acceptance by the Company promptly upon receipt of notice in writing that the work is ready for such inspection.

38. *Final Estimates.*—Upon the completion and acceptance of the work, the chief engineer shall execute a certificate over his signature that the whole work provided for in this agreement has been completed and accepted by him under the terms and conditions thereof, whereupon the entire balance found to be due to the Contractor, including said retained percentage, shall be paid to the Contractor at the office of the treasurer of the Company within .... days after the date of said final certificate. Before the time of payment of said final estimate the Contractor shall submit evidence satisfactory to the chief engineer that all payrolls, material bills, and outstanding indebtedness, in connection with this work, have been paid.

....

This agreement shall inure to the benefit of and be binding upon the legal representatives and successors of the parties respectively.

In Witness Whereof, the parties hereto have executed this agreement in .... the day and year first above written.

Witness:

....

....

BOND.

Know All Men by These Presents:

....

That the undersigned ....
.... are held and bound unto the ....
.... in the sum of ....
.... dollars, lawful money of the United States of America, to be paid to said .... its successors and assigns, to which payment the undersigned, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns.

The condition of this obligation is that if .... Contractor shall faithfully furnish and do everything required in the contract, executed in writing, dated .... 191... between .... Contractor, and .... Company for .... this obligation shall become of no effect; otherwise it shall continue in full force.

Signed, sealed and delivered this .... day of .... 191...

Attest:

....

....

The form of bond submitted contains no *notarial* or official acknowledgment. In certain states such acknowledgment may be necessary. Decision as to the fact should be made by the Legal Department of each company.

Attention is called to the fact that the proposed form of bond is intended solely for use in connection with the adopted Uniform Contract Form.

Discussion on Uniform General Contract Forms.

The report was presented by Chairman Lee. The form of bond and uniform contract form was adopted and the committee continued.

SIGNS, FENCES AND CROSSINGS

The following work was assigned for the consideration of the committee:

(1) Report on the economy of concrete and metal signs and signals as compared with wood.

(2) Report on the economy of concrete and metal as compared with wood for fence posts.

(3) Investigate methods used and the comparative costs of repainting crossing and other signs; also present specifications for whitewashing cattle-guard wing fences.

REVISION OF MANUAL.

The committee made a careful examination of the subject-matter of the Manual. A few new definitions were added, the diction in a number of the old ones was improved and others were abbreviated and made more concise.

An additional class of fence has been added under "Specifications for Standard Right-of-Way Fences" to cover fences constructed of galvanized ribbon, smooth round or barbed

wire, all widely used but not heretofore provided for in the Manual. A slight change has been made in the spacing of the longitudinal wires of the different classes of fence, to conform to the standard spacing used by several of the largest American manufacturers. The length of end, corner, anchor and gate posts has been reduced from 9 to 8 ft. and intermediate or line posts from 8 to 7 ft., as these lengths agree with the standards of a large percentage of railways reporting on fence posts this year. As concrete posts have heretofore been promoted as a suitable substitute for wood, this class of posts has been added under "material."

The paragraphs bearing on elastic limit and tensile strength of wires of various gages in which no values have heretofore been given, have been eliminated because the strength of new wire is more than ample and any standard which might be adopted would only hold good until oxidation began.

Paragraphs 1 and 2, relating to galvanizing fence wire, have been revised to apply only to electrically wended fencing, as the committee is unable to learn of any advantage in galvanizing other forms of fencing after it is fabricated. The joints in the hinge type of woven fencing would be disturbed during erection, which would defeat the object of regalvanizing, to say nothing of the waste of spelter which would fill the crevices in the locks or joints.

W. F. STROUSE,
Chairman Committee on Signs, Fences and Crossings.

A number of minor changes were made in the text bearing on "Snow Fences, Snow Sheds and Recommended Methods of Snow Removal."

The use of the term "stock-guard" instead of "cattle-guard" is considered desirable in view of the fact that the laws in over half the states require a guard to be of such type as will turn not only horses, cattle and mules, but sheep and swine as well. The definition of "Section" was eliminated, as some forms of stock-guards are not made up in sections.

Specifications for Standard Right-of-Way Fences.

1. *Classes.*—Standard right-of-way fences shall be divided into four classes, the height to conform to statutory requirements, generally about 4 ft. 6 in. above the ground.

2. *First Class.*—A first-class fence shall consist of 9 longitudinal smooth galvanized steel wires; the top and bottom wires shall be No. 7 gage, and the intermediate and stay wires No. 9 gage. The spacing of the longitudinal wires commencing at the bottom shall be 4, 4½, 5, 5½, 6, 7, 8 and 9 in. The bottom wire shall be 5 in. above the ground and the stay wires shall be spaced 12 in. apart. When used as a hog-tight fence, the bottom wire shall be not over 3 in. above the ground, with a strand of barbed wire 1½ in. below same.

3. *Second Class.*—A second-class fence shall consist of 7 longitudinal smooth galvanized steel wires; the longitudinal and stay wires shall be No. 9 gage. The spacing of the longitudinal wires, commencing at the bottom, shall be 6½, 7, 7½, 8, 8½ and 9 in. The bottom wire shall be 7 in. above the ground and stay wires shall be placed 18 in. apart.

4. *Third Class.*—A third-class fence shall consist of 5 longitudinal smooth galvanized steel wires; the longitudinal and stay wires shall be No. 9 gage. The spacing of the longitudinal wires, commencing at the bottom, shall be 7½, 8, 8½ and 9 in. The bottom wire shall be 9 in. above the ground and the stay wires shall be spaced 24 in. apart.

5. *Fourth Class.*—A fourth-class fence shall consist of 5 strands of galvanized steel ribbon, smooth round or barbed wire fencing. The spacing of the wires, commencing at the bottom, shall be 10, 10, 12 and 12 in. The bottom wire shall be 10 in. above the ground.

The longitudinal wires of all woven wire fencing under classes 1, 2 and 3 shall be provided with tension curves to take up expansion and contraction.

6. *Wood Posts.*—Posts shall be made of cedar, locust, chestnut, Bois d'Arc, white oak, mulberry, catalpa or other durable wood native to the locality or of treated timber. They shall be straight and free from splits, rot or other defects. If sawed or split posts are used, their dimensions shall be at least equal to those hereinafter specified for round posts.

7. *End Posts, etc.*—End, corner, anchor and gate posts shall be at least 8 ft. long and 8 in. in diameter at the small end, set 3 ft. 4 in. in the ground.

8. *Intermediate Posts.*—Intermediate or line posts shall be at least 7 ft. long and 4 in. in diameter at the small end, set 2 ft. 4 in. in the ground.

9. *Braces.*—Braces for end, corner, anchor and gate posts shall be made of intermediate or line posts or 4 in. by 4 in. sawed lumber of a quality equal in durability to that of the posts, and free from large knots, splits, rot and other defects.

10. *Concrete Posts.*—Concrete posts shall consist of one part Portland cement to four parts run of pit gravel; or one part Portland cement, two parts clean, sharp sand and four parts crushed stone of low absorption or screened gravel. Gravel or broken stone should be of such size as will pass through a ½-in. screen but be retained on a ¼-in. screen.

11. *End Posts, etc.*—End, corner, anchor and gate posts shall be at least 8 ft. long, 6 in. square at the top and 8 in. square at the base, set 3 ft. 4 in. in the ground. The reinforcement shall consist of 4⅜ in. square twisted rods.

12. *Intermediate Posts.*—Intermediate or line posts shall be at least 7 ft. long, 4 in. at the top and 5½ in. at the base, set 2 ft. 4 in. in the ground. The reinforcement shall consist of 3 in. or 4¼ in. square twisted rods, depending on the design of the posts.

13. *Braces.*—Braces for end, corner, anchor and gate posts shall be made of concrete, 4 in. by 4 in. in section, reinforced with 4¼ in. square twisted rods.

14. *Wire.*—Woven wire fences shall be constructed of basic open-hearth galvanized steel wire. It must stand, winding tight around wire of the same size, without sign of fracture.

15. *Locks.*—The locks or fastenings at the intersection of the longitudinal and stay wires shall be of such designs as will prevent them from slipping either longitudinally or vertically.

16. *Staples.*—The staples used for fastening the longitudinal wires to the posts shall be made of No. 9 galvanized steel wire. They shall be 1 in. long for hardwood and 1½ in. long for softwood.

17. *Galvanizing.*—The galvanizing shall consist of an even coating of zinc, which shall withstand one-minute immersion tests in a solution of commercial sulphate of copper crystals and water, the specific gravity of which shall be 1,185 and whose temperature shall be from 60 to 70 deg. F. Immediately after each immersion the sample shall be washed in water and wiped dry. If the zinc is removed, or a copper colored deposit formed at the end of the fourth immersion, the lot of material from which the sample is taken shall be rejected.

18. *Manufacture.*—The fence shall be so fabricated as not to remove the galvanizing or impair the tensile strength of the wire.

19. *End, Corner, Anchor and Gate Posts.*—End corner, anchor and gate posts shall be set vertical, at least 3 ft. 4 in. in the ground, thoroughly tamped, braced and anchored.

20. *Intermediate or Line Posts.*—Intermediate or line posts shall be set at least 2 ft. 4 in. in the ground, and 16½ ft. apart.

21. *Post Holes.*—Holes of full depth shall be provided for all end, corner, anchor and gate posts, even if blasting must be resorted to. For intermediate or line posts, where rock is encountered, not more than 2 adjacent wood posts shall be set on sills 6 in. by 6 in. by 4 ft. long,

braced on both sides by 2 in. by 6 in. braces, 3 ft. long. Holes shall be provided for all other posts. Posts shall be set with the large end down and in perfect line on the side on which the wire is to be strung. Arter the fence is erected, the tops of the wooden posts shall be sawed off with a one-fourth pitch, the high side being next the wire and 2 in. above it.

22. *Anchoring.*—Wood end, corner, anchor and gate posts shall be anchored by gaining and spiking two cleats to the side of the posts, at right angles to the line of the fence, one at the bottom, the other just below the surface of the ground. The cleat near the ground surface shall be put on the side next the fence and the bottom cleat shall be put on the opposite side. Intermediate wood posts set in depressions of the ground shall be anchored by gaining two cleats into the side near the bottom of the post, same to be properly spiked.

23. *Cleats, Sills, etc.*—All cleats shall be 2 in. by 6 in. by 2 ft. long. All sills, braces and cleats shall be made of sawed timber of a quality equal in durability to that of the posts.

24. *Bracing.*—Wood end, corner, anchor and gate posts shall be braced by using an intermediate or line post or a piece of 4 in. by 4 in. sawed lumber of a quality equal in durability to that of the posts, gained into the end, corner, anchor or gate post, about 12 in. from the top and into the next intermediate or line post about 12 in. from the ground, and be securely spiked. A cable made of a double strand of No. 9 galvanized soft wire looped around the end, corner, anchor or gate post near the ground line, and around the next intermediate or line post about 12 in. from the top, shall be put on and twisted until the top of the next intermediate or line post is drawn back about 2 in. Four in. by four in. reinforced braces shall be used with concrete posts.

25. *Stretching.*—Longitudinal wires shall be stretched uniformly tight and parallel; stays shall be straight, vertical and uniformly spaced. Wires shall be placed on the side of the post away from the track.

26. *Stapling.*—Staples shall be set diagonally with the grain of the wood and driven home tight. The top wires shall be double stapled.

27. *Splicing.*—Approved bolt clamp splice or wire splice made as follows may be used: the ends of the wires shall be carried 3 in. past the splicing tools and wrapped around both wires backward toward the tool for at least 5 turns, and after the tool is removed, the space occupied by it shall be closed by pulling the ends together.

The use of smooth wire in preference to barbed wire is recommended for right-of-way fences.

The use of heavy smooth wire, or a plank at the top of a barbed wire fence, is recommended.

Galvanized Wire Fencing.

(1) The rapid deterioration of modern woven galvanized fence wire is caused by the coating of zinc being too thin and of an uneven thickness. To provide better protection for the wire and a longer life for the fence, it is necessary to secure an increased uniform thickness of zinc coating on the wire. To insure that the galvanizing is intact after the fence has been fabricated, it is recommended that a second coating of zinc be applied to electrically welded fencing after it is manufactured.

(2) It is further recommended that wire which has received a zinc coating which will stand the test prescribed in the specifications be used in the manufacture of fencing, and that in the case of electrically welded fencing, the galvanizing be applied after it has been fabricated.

Gates for Right-of-Way Fences.

A hanged metal gate is recommended.

The width of farm gates should not be less than 12 ft., depending upon the size of agricultural machinery in use in the vicinity, or as required by the laws of the states through which the railroad operates. The minimum height of farm gates should be 4 ft. 6 in. from the surface of the roadway.

Farm gates should be hung so as to open away from the track, and, if hinged, should swing shut by gravity.

CONCRETE FENCE POSTS.

(1) Concrete fence posts are practical and economical and a suitable substitute for wood.

(2) Reinforcement should be placed as near to the surface of the post as possible; ½-in. from the surface is the best location.

(3) Posts should taper from the base to the top.

(4) Posts should not be less than 5½ in. wide at the base and 4 in. at the top.

(5) Concrete should consist of one part cement to four parts run of pit gravel; or one part cement, two parts sand and four parts crushed stone of low absorption, or screened gravel. Gravel or crushed stone should not be less than ¼-in. nor more than ½-in. in size. Concrete should be of a quaking consistency.

(6) Molds should have a jogger or vibratory motion, while concrete is being placed to compact it and smooth up the surfaces of the posts.

(7) Posts should not be made out of doors in freezing weather. They should not be exposed to the sun, and should be sprinkled with water the first eight or ten days after being made to aid curing.

(8) Molds should be carefully oiled or soaped to prevent the concrete sticking to them.

(9) Posts should be cured for not less than 90 days, when cured naturally, before being set or shipped.

(10) Posts should be carefully handled and packed in straw, sawdust or other suitable material for shipment.

TRACK CONSTRUCTION AND FLANGEWAYS AT PAVED STREET CROSSINGS AND IN PAVED STREETS.

(1) Treated ties should be used, laid on a bed of crushed rock, gravel or other suitable material, not less than 8 in. in depth, placed in about 3-in. layers, each thoroughly rammed to compact it.

(2) Vitrified tile drains not less than 6 in. in diameter, with open joints, leading to the nearest point from which efficient drainage may be obtained, or with sufficient outlets to reach sewers or drainage basins, should be laid on either side of and between tracks, parallel with the ballast line and outside of the ties.

(3) One hundred and forty-one-lb. 9-in. depth girder rail, or a similar section, with suitable tie-plates and screw-spikes, should be used. Tracks should be filled in with crushed rock, gravel or other suitable material, allowing for a 2-in. cushion of sand under the finished pavement.

(4) Ballast should be thoroughly rammed as it is installed to prevent settlement of paving foundations. Two inches of good sharp sand should be placed on top of the ballast.

(5) Paving must conform to municipal requirements, granite or trap rock blocks preferred. Hot tar and gravel should be poured into the joints as a binder.

ECONOMY OF CONCRETE AND METAL SIGNS AS COMPARED WITH WOOD.

Sixty-two replies were received in response to inquiries relative to concrete, metal and wood signs. Fifteen roads report having used concrete signs, generally of the simpler type, 39 roads report the use of metal in signs, either complete or in combination with wood or concrete, while all roads with one or two exceptions use wooden signs.

The use of concrete does not date back more than 12 or 15 years, and in most of the cases reported, it covers a much shorter period. Comparatively few roads, therefore, were willing to go on record as to the probable life of concrete signs. With our limited experience in this direction, it could only be a matter of conjecture to specify any definite period. Another consideration, and one having a very important bearing on the life of concrete structures, is the quality of the concrete. To keep the cost within reasonable bounds, concrete signs should be designed along mathematical lines. This generally means a light structure with just sufficient reinforcement to meet the requirements, based on first-class material and workmanship. In practice, this condition is not always realized and defects frequently develop some time after the work has been completed and put in service. It is, therefore impossible to estimate the life until after the quality has been determined.

In a number of instances, cast or wrought plates are attached to wood or concrete posts or other structures. The use of signs made wholly of cast-iron is confined to comparatively few roads, while the use of wrought posts and cast plates is quite general. The use of old T-rail for posts was reported by several roads. Old boiler tubes are frequently used in making wrought posts. It would appear more economical to use new material unless the old tubes are in good condition. The life of wrought-iron or steel signs depends largely on the condition of the tubes and plates when used and the means employed for their protection. If the tubes are filled with concrete as specified by some roads and set in a concrete base which should extend several inches above the ground, and then properly protected by paint, they should last for 30 to 40 years. Some roads have estimated their life as 30 years, while others have stated it was indeterminate; some have made no estimate.

The committee is of the opinion that where either cast-

iron or wrought-iron or steel signs are properly protected by paint and concrete, they will last as long as concrete and from two to three times as long as wood.

As the posts of signs generally fail first, and as some kinds of wood are more durable than others, it is very essential that good posts be provided if wood is used. In some cases, preservatives have been used with good results. This is particularly true where creosoted timber is used for the base, the superstructure of untreated timber being bolted to the same. The average life of wood signs as reported would appear to be about ten years, although many place it as low as eight years.

All contributors were asked to express their opinions as to the relative economies in the use of different materials. Ten roads express a preference for concrete, six favor metal and eleven wood. Twelve roads show variable preferences which are governed by circumstances and 20 roads make no reply.

ECONOMY OF CONCRETE AND METAL AS COMPARED WITH WOOD FOR FENCE POSTS.

In response to inquiries relative to fence posts, 72 replies were received. Seventeen roads report the use of concrete posts, three are using a few experimentally, and the balance in lots running as high as 15,000 to 20,000. Sixteen roads are using metal posts, 13 having purchased them from manufacturers, and 3 having made them with their own forces. All roads, with two or three exceptions, are using wood posts.

Concrete posts have been in service covering periods ranging from 6 months to 9 years; a number of roads having used them 5 or 6 years. Their use has not covered a sufficiently long period to enable anyone to give any very definite information as to their life. Some have placed it at 15 to 50 years, others 10 to 20, while most of the roads have advised it was indefinite or gave no reply. With proper material and workmanship in their manufacture, there seems to be no reason why they should not be good for 30 to 40 years if not subjected to sudden shocks or severe strains.

The percentage damaged in handling was reported by the roads as ranging from 0 to 5 per cent, with a probable average of not over 2.5 per cent, the damage in many cases occurring while the posts were being removed from the molds. The method of shipment varied from loading on flat cars crosswise with no packing to the use of hay, straw or sawdust. The average cost of line posts would seem to be about 25 cents, the anchor or corner posts 50 cents, while the average cost to install would probably run about 12 cents.

Some roads are just beginning to use metal fence posts, while others have had them in use as long as six years. Quite a few roads have been using them two or three years. As in the case of concrete, their use has not covered a sufficiently long period to determine definitely their life. It has been variously estimated at 10 to 20 years, except in old boiler tubes, which fail in 6 to 8 years. The line posts cost about 25 cents, end posts $1.60 and corner posts $2.30. The cost of setting line posts ranges from 2 to 10 cents, with a probable average of 6 cents. The cost of setting corner or end posts varies from $1.00 to $1.50 if set in concrete, not including the cost of materials.

Information secured from 66 railroads relative to wood posts shows that the prevailing timber used is cedar, locust, chestnut and oak, with some Bois d'Arc, catalpa, cypress and pine. The life varies from 5 to 6 years for oak and pine to 20 years for the cedars and 40 to 50 years for Bois d'Arc. The loss by fire in most cases is low, but in some localities runs as high as 25 per cent, while several roads report as high as 50 per cent.

Only three companies have undertaken the cultivation of timber for posts, two reporting results satisfactory and one poor. The prices paid for posts range from 7 to 38 cents, the average being about 18 cents, with about 2 cents for delivering along line of road. The average cost to set wood posts is about 10 cents. A number of roads advise they are considering changing to concrete or metal. Others advise that where timber is plentiful and cheap, wood is most economical.

From some investigations made bearing on the relative economy of concrete, metal and wood posts, it was found that where cedar and locust posts, for example, can be bought for 16 to 18 cents, with a probable average life of 15 years, there is little economy in using concrete posts at 25 cents each unless their life can be definitely fixed at over 30 years.

In the report of this committee two years ago, reference was made to concrete posts which were being used by the Board of Water Supply of the City of New York around Ashokan reservoir, spoil banks, borrow pits and gate houses and other locations along the Catskill Aqeduct, comprising about 150 miles of fencing, making it no doubt the largest individual user of concrete posts in the country at this time. This year the committee presents some additional information.

In enclosing the Ashokan reservoir property, over 14,000 concrete posts were used in constructing about 43 miles of fencing, the posts being placed at intervals of 16 ft. Straining or anchor posts were used on straight lines at intervals of about 300 ft. and at all abrupt angles. These posts were 3½ in. square at the top, 8 in. square at the bottom and 7 ft. 9 in. long. They were reinforced with four ¼-in. square twisted steel bars, held in position by 5 hoops made of the same material. The line posts were "U" shaped, 5½ in. over all at the bottom and 3½ in. at the top, reinforced with four No. 5 U. S. steel wire gage rods. All posts were made on the site by the contractor for the fencing, the concrete consisting of one part cement to four parts aggregate in which the sand was limited to ¼ in. maximum size and the stone to such size as would pass through a ¾-in. screen and be retained on a ¼-in. screen. The specifications required that the posts be protected from the hot sun and from freezing and that they be kept moist for at least two weeks after being cast. As most of them were set during the years 1913 and 1914, the Board has had no opportunity to judge as to their durability; but as they are not subject to deterioration due to the elements as wood and metal, it is but fair to assume the average life of the posts to be at least 25 years.

As stated above, the specifications required the posts to be kept moist for a period of two weeks. It was found that occasional sprinkling was not satisfactory and that it was necessary to cover them with something that would retain the moisture. After being cured from 15 to 30 days, the posts were hauled from the place of manufacture to the site on wagons equipped with a platform so that they were supported their entire length, no packing of any kind being used. The number damaged in handling probably did not exceed 1.5 per cent. In common with the property of other large corporations, the trespasser considered it necessary to try his marksmanshp either with gun or stones, with the result that some posts have had the tops broken off. The posts in general have been satisfactory, but would perhaps have been more satisfactory had the square posts used as end or anchor posts been made with a heavier section, as an unbalanced strain occasionally broke the posts off at the surface of the ground.

These posts were furnished under a contract which included the manufacture, delivery and setting, but not the excavation of the hole or the cement and reinforcement used in their manufacture. At the contract prices, the cost of the line posts in place was $1.47 each, distributed as follows: Post $0.90, cement $0.145, reinforcement $0.175, excavation and backfilling $0.25. The corner and anchor posts, set in concrete with one brace and thrust block, complete in place, cost $13.81, made up of the following items: Post $1.30, cement $0.32, reinforcement $0.43, earth excavation $0.50, concrete to refill post hole $6.00, galvanized angle-iron brace $3.02, excavation for thrust block, earth $0.14, concrete for thrust block $2.10. Post holes for line posts in rock cost $0.40 each additional and for corner and anchor posts and thrust blocks $1.02 additional.

TESTS OF CONCRETE POSTS.

The tests of concrete posts, of which mention was made in last year's report, have been completed. The purpose of these tests was to determine the relative strength of the different types of concrete posts. The tests were made at the Lewis Institute, Chicago, by D. A. Abrams of the Institute, as director by the committee and with his assistance.

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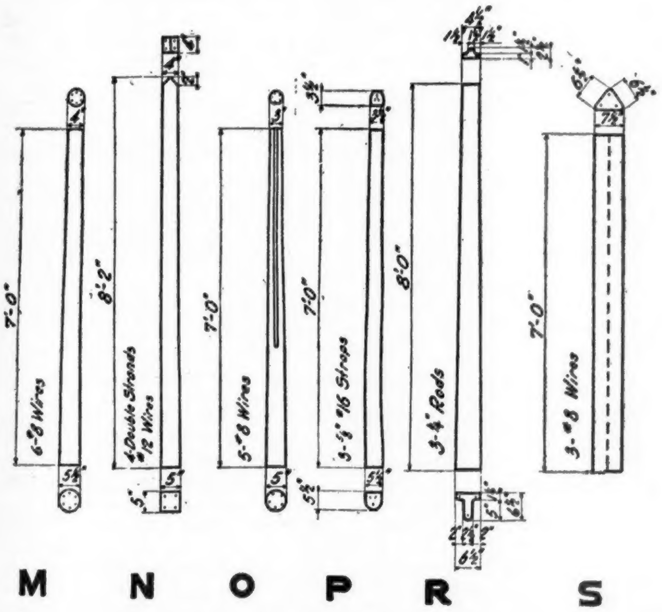
¼ in. or larger than ½ in. in size. If it is not possible to obtain the above materials, the concrete mixture should consist of one part cement to four parts of pit-run gravel, with the above maximum limit in size. Concrete should be of quaking consistency.

"The posts should not be exposed to the sun, and should be sprinkled with water the first eight or ten days after being made, to aid curing. It is expected that the tests will be made about 60 days after the completion of the posts. Shipping directions will be furnished later. Posts should be crated to avoid breakage due to improper handling in shipment. There is no objection to placing several posts in a crate if the weight is not too great.

"In addition to the posts, five 4-in. cubes should be made of the same concrete materials and at the same time as the posts and shipped with them. Care should be taken to have the concrete in the cubes of the same consistency and density as that in the posts.

"A full description of the materials used, including water, cement, sand and gravel, and the method involved in making the posts, should be furnished. Each post should be marked with the date on which it is made."

In general the instructions were complied with, but two sets of posts were shipped uncrated and two companies did not furnish the test cubes called for. Some of the



Types of Concrete Posts Tested.

posts of one type shipped without crating showed quite distinct horizontal cracks, but in the tests failure occurred at other points. Two of the types were eight-foot posts. In making the tests, however, the extra foot was neglected —that is, they were supported and loaded at the same distance from the lower end as the seven-foot posts.

The committee desired to subject the posts to conditions similar to those occurring in actual use, and decided on three tests—a simple beam, a cantilever, and an impact test. For the simple-beam test a Riehle compression machine was used, the supports being placed 3 in. and 6 ft. 6 in. from the lower end of the post and the load applied 2 ft. 6 in. from the lower end.

For the cantilever and impact test a method for holding the post had to be devised. This was accomplished by constructing on a 12-in. by 12-in. timber a heavy wood box having an area of about one square foot and a depth of 2 ft. 6 in. The post was placed in the box in an upright position, and screened gravel, about one-quarter to three-quarters of an inch in size, was poured around it and lightly tamped. The load was applied 6 ft. 6 in. from the bottom of the post to bring the fence side of the post into tension. The pull was measured with a tension dynamometer.

For the impact test the post was placed in the box, as before, and a wooden washer or plug, fitting loosely about the post, was bolted down on top of the gravel to prevent its falling out. The post and box were then turned to a horizontal position, which brought the upper end of the post under a weight which could be moved vertically in a pair of guides or leads. This weight was of wood loaded to 33 lbs. The first drop was for a distance of 5 in., and this was increased 1 in. at a time until failure of the post occurred.

Tests of the reinforcement showed the following average values of the yield point and the ultimate load:

Post.	Yield Point in lbs. per Sq. In.	Ultimate Load in lbs. per Sq. In.
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		72,000
P	41,900	50,100
R	42,600	56,700
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In the case of Post "O" it was not possible to obtain the yield point on the metal, because of the fact that the wires were crimped. Apparently there were two grades of steel used in this wire.

In Table 8 a comparison is made of the breaking load, as determined in the contilever test, per pound of post and per pound of reinforcement. It is felt that these units afford a good basis of comparison, because they have direct bearing on the cost of making as well as the cost of handling the post.

Attention is called to the fact that in spite of the wide variation in the strength of the concrete, all of the posts failed in tension, and this brings out the important relationship which the quantity and distribution of reinforcement bear to the strength of the posts. It is believed that there is an advantage in using some type of reinforcement in which the position of the longitudinal members is definitely fixed near the outside of the post. A dense concrete is required to thoroughly protect the steel in this position.

TABLE 8—TESTS OF REINFORCED CONCRETE FENCE POSTS.

Type of Post	Average weight in lbs.	Average breaking load, in cantilever test applied 48" above the ground line, in lbs.	Breaking load, as before, per lb. of post	Estimated weight of reinforcement in lbs.	Breaking load, as before, per lb. of reinforcement
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N	147	231	1.57	1.79	130
O	75	325	4.33	2.41	135
P	80	185	2.31	2.59	71
R	90	335	3.72	2.55	131
S	150	135	.90	1.44	94

METHODS USED IN REPAINTING SIGNS, AND SPECIFICATIONS FOR WHITEWASHING CATTLE-GUARD WING FENCES.

Sixty-two replies were received in response to inquiries relative to methods used in repainting signs and whitewashing cattle-guard wing fences. The prevailing practice in vogue on the majority of the railroads from which replies were received is to send paint gangs of from two to six men, supplied with material and equipment, over the road, on speeders or hand cars, who first repaint the posts and backgrounds of the signs and then either return to paint the inscriptions or are followed by another gang about two days later which does that class of work. In a few instances when signs need repainting, they are replaced by new ones and the old ones are sent to the shops for repairs and repainting. Thirty-three roads use stencils in repainting inscriptions except in the case of special lettering, which is done freehand. A few roads advise their use to a limited extent only, while 11 roads report they do not use them for any work.

The replies indicate that white lead and linseed oil are almost universally used where the posts and backgrounds are painted white, and lamp black and linseed oil for black lettering, etc., on wood signs. For repainting metal signs, the same materials are generally used, although in a limited number of cases red lead and graphite are used. Some roads report the use of commercial paints, of their standard colors. Over half the roads have no specifications, but use leads and oils in proper proportions or commercial paints of known reputation; others, in lieu of specifications, give the proportions of the ingredients used.

There does not seem to be any well-defined general practice in regard to frequency of repainting signs. Some roads repaint every year, others every two years, while others advise they repaint every three or four years or when needed. Metal signs require more frequent repainting than wood to keep them in proper condition. The committee has been unable to get any very definite information on cost data.

Most roads whitewash their cattle-guard wing fences, but a few use cold water paint. Some roads advise they have

iron or wrought-iron or steel signs are properly protected by paint and concrete, they will last as long as concrete and from two to three times as long as wood.

As the posts of signs generally fail first, and as some kinds of wood are more durable than others, it is very essential that good posts be provided if wood is used. In some cases, preservatives have been used with good results. This is particularly true where creosoted timber is used for the base, the superstructure of untreated timber being bolted to the same. The average life of wood signs as reported would appear to be about ten years, although many place it as low as eight years.

All contributors were asked to express their opinions as to the relative economies in the use of different materials. Ten roads express a preference for concrete, six favor metal and eleven wood. Twelve roads show variable preferences which are governed by circumstances and 20 roads make no reply.

ECONOMY OF CONCRETE AND METAL AS COMPARED WITH WOOD FOR FENCE POSTS.

In response to inquiries relative to fence posts, 72 replies were received. Seventeen roads report the use of concrete posts, three are using a few experimentally, and the balance in lots running as high as 15,000 to 20,000. Sixteen roads are using metal posts, 13 having purchased them from manufacturers, and 3 having made them with their own forces. All roads, with two or three exceptions, are using wood posts.

Concrete posts have been in service covering periods ranging from 6 months to 9 years; a number of roads having used them 5 or 6 years. Their use has not covered a sufficiently long period to enable anyone to give any very definite information as to their life. Some have placed it at 15 to 50 years, others 10 to 20, while most of the roads have advised it was indefinite or gave no reply. With proper material and workmanship in their manufacture, there seems to be no reason why they should not be good for 30 to 40 years if not subjected to sudden shocks or severe strains.

The percentage damaged in handling was reported by the roads as ranging from 0 to 5 per cent, with a probable average of not over 2.5 per cent, the damage in many cases occurring while the posts were being removed from the molds. The method of shipment varied from loading on flat cars crosswise with no packing to the use of hay, straw or sawdust. The average cost of line posts would seem to be about 25 cents, the anchor or corner posts 50 cents, while the average cost to install would probably run about 12 cents.

Some roads are just beginning to use metal fence posts, while others have had them in use as long as six years. Quite a few roads have been using them two or three years. As in the case of concrete, their use has not covered a sufficiently long period to determine definitely their life. It has been variously estimated at 10 to 20 years, except in old boiler tubes, which fail in 6 to 8 years. The line posts cost about 25 cents, end posts $1.60 and corner posts $2.30. The cost of setting line posts ranges from 2 to 10 cents, with a probable average of 6 cents. The cost of setting corner or end posts varies from $1.00 to $1.50 if set in concrete, not including the cost of materials.

Information secured from 66 railroads relative to wood posts shows that the prevailing timber used is cedar, locust, chestnut and oak, with some Bois d'Arc, catalpa, cypress and pine. The life varies from 5 to 6 years for oak and pine to 20 years for the cedars and 40 to 50 years for Bois d'Arc. The loss by fire in most cases is low, but in some localities runs as high as 25 per cent, while several roads report as high as 50 per cent.

Only three companies have undertaken the cultivation of timber for posts, two reporting results satisfactory and one poor. The prices paid for posts range from 7 to 38 cents, the average being about 18 cents, with about 2 cents for delivering along line of road. The average cost to set wood posts is about 10 cents. A number of roads advise they are considering changing to concrete or metal. Others advise that where timber is plentiful and cheap, wood is most economical.

From some investigations made bearing on the relative economy of concrete, metal and wood posts, it was found that where cedar and locust posts, for example, can be bought for 16 to 18 cents, with a probable average life of 15 years, there is little economy in using concrete posts at 25 cents each unless their life can be definitely fixed at over 30 years.

In the report of this committee two years ago, reference was made to concrete posts which were being used by the Board of Water Supply of the City of New York around Ashokan reservoir, spoil banks, borrow pits and gate houses and other locations along the Catskill Aqeduct, comprising about 150 miles of fencing, making it no doubt the largest individual user of concrete posts in the country at this time. This year the committee presents some additional information.

In enclosing the Ashokan reservoir property, over 14,000 concrete posts were used in constructing about 43 miles of fencing, the posts being placed at intervals of 16 ft. Straining or anchor posts were used on straight lines at intervals of about 300 ft. and at all abrupt angles. These posts were 3½ in. square at the top, 8 in. square at the bottom and 7 ft. 9 in. long. They were reinforced with four ¼-in. square twisted steel bars, held in position by 5 hoops made of the same material. The line posts were "U" shaped, 5½ in. over all at the bottom and 3½ in. at the top, reinforced with four No. 5 U. S. steel wire gage rods. All posts were made on the site by the contractor for the fencing, the concrete consisting of one part cement to four parts aggregate in which the sand was limited to ¼ in. maximum size and the stone to such size as would pass through a ¾-in. screen and be retained on a ¼-in. screen. The specifications required that the posts be protected from the hot sun and from freezing and that they be kept moist for at least two weeks after being cast. As most of them were set during the years 1913 and 1914, the Board has had no opportunity to judge as to their durability; but as they are not subject to deterioration due to the elements as wood and metal, it is but fair to assume the average life of the posts to be at least 25 years.

As stated above, the specifications required the posts to be kept moist for a period of two weeks. It was found that occasional sprinkling was not satisfactory and that it was necessary to cover them with something that would retain the moisture. After being cured from 15 to 30 days, the posts were hauled from the place of manufacture to the site on wagons equipped with a platform so that they were supported their entire length, no packing of any kind being used. The number damaged in handling probably did not exceed 1.5 per cent. In common with the property of other large corporations, the trespasser considered it necessary to try his marksmanshp either with gun or stones, with the result that some posts have had the tops broken off. The posts in general have been satisfactory, but would perhaps have been more satisfactory had the square posts used as end or anchor posts been made with a heavier section, as an unbalanced strain occasionally broke the posts off at the surface of the ground.

These posts were furnished under a contract which included the manufacture, delivery and setting, but not the excavation of the hole or the cement and reinforcement used in their manufacture. At the contract prices, the cost of the line posts in place was $1.47 each, distributed as follows: Post $0.90, cement $0.145, reinforcement $0.175, excavation and backfilling $0.25. The corner and anchor posts, set in concrete with one brace and thrust block, complete in place, cost $13.81, made up of the following items: Post $1.30, cement $0.32, reinforcement $0.43, earth excavation $0.50, concrete to refill post hole $6.00, galvanized angle-iron brace $3.02, excavation for thrust block, earth $0.14, concrete for thrust block $2.10. Post holes for line posts in rock cost $0.40 each additional and for corner and anchor posts and thrust blocks $1.02 additional.

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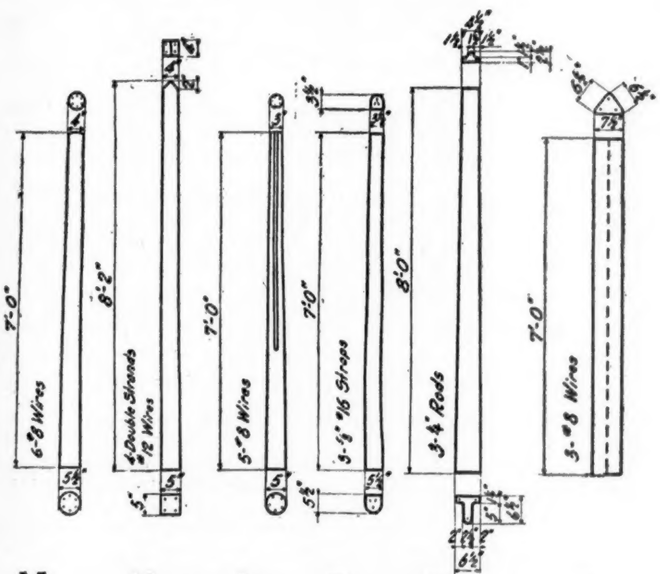

M N O P R S

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Most roads whitewash their cattle-guard wing fences, but a few use cold water paint. Some roads advise they have

under consideration abandoning the practice, as the results hardly justify the expense. There is considerable variation in the specifications for whitewash. Some roads report the use of ordinary lime and water, others add salt, glue, whiting, rice, etc.

In the report submitted by this committee two years ago, some figures were presented on the cost of setting concrete, metal and wood posts. This year the committee has secured some information from the Baltimore & Ohio, giving cost data on two sections of test fence, each 4,620 ft. in length, erected in May, 1913, on its Philadelphia division. Metal posts were used in one section and wooden posts in the other. Electrically welded wire fencing made of No. 9 galvanized steel wire was used in both cases. Both sections of fence were erected on reasonably level ground and where the soil was composed largely of clay and sand. The metal posts were driven 2½ ft. in the ground and the soil around them tamped to make them more rigid. The wooden posts were set in the usual manner, in holes dug about 2½ ft. deep, the holes being backfilled and tamped. All the posts were 7 ft. in length. The steel end or anchor posts were set at intervals of 40 rods (the length of a large roll of wire) in concrete about 30 in. deep and 12 in. square. The steel intermediate or line posts were set at intervals of 16½ ft. or as near thereto as the condition of the ground would permit. The same spacing wes used in setting the wooden posts. The average cost of labor for driving and tamping 279 steel intermediate or line posts was $0.0573 each. The average cost of digging holes, distributing and setting 288 wooden intermediate or line posts was $0.0879 each. The cost of labor setting the steel end or anchor posts was $1.22 each. The average cost of labor erecting the section of fence in which steel posts were used was $0.18 per rod, or $57.60 per mile. The average cost of labor erecting the section of fence where wooden posts were used was $0.1576 per rod, or $50.43 per mile. The average cost of stretching the wire on metal posts was $0.0613 per rod, or $19.62 per mile. The average cost of stretching the wire on wooden posts was $0.0672 per rod, or $21.50 per mile. From the above it will be noted the cost of setting a wooden post was about 50 per cent greater than that of setting a metal post, but the average cost of erection of the fence complete was less where wooden posts were used than where metal posts were used. This was due to the high cost of setting anchor posts. The metal line posts cost $0.245 each, or $0.3023 in place; the wooden posts cost $0.18 each, or $0.2679 in place. A recent examination of the above metal posts failed to detect any indication of corrosion, although the wire fencing showed unmistakable evidence of rust.

CONCLUSIONS.

Subject No. 1.

(1) Concrete is a practical, economical and satisfactory material for the more simple forms of signs of small or moderate size.

(2) Metal is a practical, economical and satisfactory material for the more complicated forms of signs of medium size.

(3) Wood is the most economical and satisfactory material for the larger forms of signs, particularly where timber is plentiful and cheap.

Subject No. 2.

(1) Concrete is a practical, economical and satisfactory material for fence posts, where suitable timber is scarce and expensive.

(2) The use of metal fence posts has not as yet covered a sufficient period to demonstrate their practical and economical qualities for that purpose.

(3) Wood is the most economical and satisfactory material for fence posts in localities where timber is plentiful and cheap.

Subject No. 3.

(1) The most practical method of repainting signs is to send paint gangs with material and equipment over the road on speeders or motor cars.

(2) White lead and linseed oil with pigments of proper coloring and lamp black and linseed oil for lettering are the most practical and satisfactory paints for both wood and metal signs.

RECOMMENDATIONS.

(1) In view of the variation in the design of concrete, metal and wood signs, and the consequent variation in cost, and also the comparatively short time that concrete has been used for signs, the committee finds itself unable to present a complete report this year, and it therefore recommends that the material collected be accepted as information and that the subject be reassigned for next year to permit a further study of the various designs received with a view to making definite recommendations for standards to meet country-wide conditions.

(2) As both concrete and metal fence posts have been in use but a few years and their durability is still considerably in doubt, the committee is unable to present any definite information as to their relative economies as compared with wood. From a careful analysis of the information received relative to concrete and wood posts, it finds that where suitable timber is plentiful and cheap there is no economy in the use of concrete unless its life should prove much longer than now estimated. It therefore recommends that further consideration of this phase of the subject be deferred until more definite information can be secured on both concrete and metal posts.

(3) The following specification for whitewash for cattle-guard wing fences is recommended:

Take half a bushel of unslaked lime, shake it with boiling water, cover during the process to keep in the steam, strain the liquid through a fine sieve or strainer, and add to it a peck of salt, previously dissolved in warm water, three pounds of ground rice boiled to a thin paste and stirred in while hot, half a pound of Spanish whiting, and one pound of clean glue, previously dissolved by soaking in cold water and then hanging over a slow fire in a small pot hung in a larger one filled with water. Add five gallons of hot water to the mixture, stir well and let it stand a few days, covered from dirt. It should be applied hot, for which purpose it can be kept in a kettle or portable furnace.

A pint of this mixture, if properly applied, will cover one square yard, will be almost as serviceable as paint for wood, brick or stone, and is much cheaper than the cheapest paint.

W. F. Strouse (B. & O.), chairman; G. E. Boyd (D. L. & N.), vice-chairman; R. B. Abbott (P. & R.), H. E. Billman (M. P.), E. T. Brown (B. & O.), A. C. Copland (C. & O.), Arthur Crumpton (G. T.), J. T. Frame (C. G. W.), L. E. Haislip (B. & O.), Maro Johnson (I. C.), L. C. Lawton (A. T. & S. F.), G. L. Moore (L. V.), W. F. Purdy (W. P. T.), Thomas Quigley (I. C.), C. H. Splitstone (Erie), committee.

Discussion on Signs, Fences and Crossings.

The report was presented by Chairman Strouse.

Mr. Strouse: I move that the definitions that are marked with an asterisk be eliminated in the reprint of the Manual.

The President: If there is no objection to that motion it will be regarded as passed.

Robert Trimble (Penn. Lines): There is one matter that I want to call your attention to, and that is the specification as to right-of-way fence, first-class, second-class, third-class, and fourth-class. Heretofore the Association has objected to that kind of classification, because it is a class that might be criticized. Take our roadway, that is classified as first, second and third class. I think we ought to change this, and I move that that change be made.

The President: The committee will accept that suggestion.

C. Dougherty (C. N. O. & T. P.): I move that the last paragraph, under "Gates for right-of-way fences" be amended by adding, "and the end of the gate opposite the hinged end shall lap by the post a sufficient distance thoroughly to prevent it from being opened by side pressure."

The President: The committee will accept the motion. The committee moves that the specifications as read will be adopted and included in the next Manual.

(The motion was seconded and carried.)

The President: The adoption of the definitions and general requirements for surface cattle-guards will be passed on by the convention, and the same as to stock guards and general requirements. The committee moves the adoption of the report.

(The motion was carried.)

The conclusions at the end of the report were also adopted.

L. C. Fritch (Can. Nor.): Under the heading, "track construction," etc., is that to be included in the Manual?

The President: That is part of the Manual.

Mr. Fritch: Clause 3 calls for "141-lb., 9-in. depth girder rail," and I think that will be pretty expensive on some lines. I think that ought to be modified.

Mr. Strouse: In regard to the criticism of that paragraph, it states "141-lb., 9-in. depth girder rail, or similar section, with suitable tie-plates and screw-spikes, should be used." It does not necessarily tie us down to that particular weight. The idea in using that depth of rail is to take care of the ordinary style of paving, that is so frequently done, namely, the use of granite blocks, which usually range between 5½

and 6½ inches in depth, and, in addition to the block, of course, provision is made for the sand cushion. Where sheet asphalt is used on a concrete base, a shallower rail can be used, but this is the depth of rail that was recommended in one of the former reports, and it had reference particularly to the use of granite blocks for the paving.

Robert Trimble: I move that this be changed to read: "One hundred and forty-one-pound, nine-inch depth girder rail, or similar section, with suitable tie-plates, should be used for tracks laid longitudinally in streets, when the conditions require such construction. Tracks should be filled in with crushed rock, gravel or other suitable material, allowing for two-inch cushion of sand under finished pavement. For street crossings the standard track construction should be used, with such modification as may be required to suit the situation."

(The motion was carried.)

Mr. Campbell: In the fifth section, I move to strike out the words "grantie or crushed rock, block preferred," making it read "to conform to municipal requirements."

L. C. Fritch: I think the first part of that is objectionable, that they must conform to municipal requirements. The tracks are subject to vibration, and I don't think that we should bind ourselves to conform to municipal requirements.

Mr. Campbell: I will be in favor of referring this back to the committee. I do not believe the specification, as it stands, covers the situation fully. I would like to see this eliminated, and this specification put on a basis so that it will cover the whole situation.

(The motion was changed so as to eliminate this part from the Manual at the present time, and refer it back to the committee for further consideration, and was carried.)

Hunter McDonald: Does that also include the plan?

The President: That will be withdrawn also.

C. S. Churchill (N. & W.): It seems to me, in the way the heading on Paragraph 3 in the recommendations at the end of the report is worded, we are led to the conclusion that that is the standard for general use all over the country. I think we should avoid any such intimation as that. Many railroads do not practice whitewashing of fences or anything else. The wording should be made so that it should be considered as optional, not a standard of practice in use everywhere. I suggest that it be recommended wherever the practice of whitewashing is followed.

Mr. Strouse: The recommendation of the committee is the specifications adopted by the United States Government.

The President: The committee will accept the modification suggested by Mr. Churchill.

(The recommendations were read as amended and adopted, and the committee was discharged.)

ECONOMICS OF RAILWAY LOCATION

The work assigned to this committee was as follows:

(1) Study the question of grade, curvature, rise and fall and distance, and, if possible, present conclusions as to reasonable values of same in a usable form, in order that they may be of use for the information and guidance of locating engineers.

(2) Continue the important study of economics of railway operation heretofore carried on by the committee, in order that the information may lead to more economical methods in railway operation, and that information may be obtained for correcting values given to the physical features in the locating of railways.

(3) Make special efforts to collect information in regard to effects of passenger and freight traffic on the cost of maintenance.

The chairman of the committee assumed the responsibility of changing the instructions to the sub-committee having charge of subject (1) to read, "Study the question of grade, curvature, rise and fall and distance, and, if possible, present instructions to enable engineers to obtain reasonable values for grade, curvature, rise and fall and distance."

If the methods outlined by this committee are approved, the immediate work for the future will be:

(1) Make a study of the resistance of trains running between 35 and 75 miles an hour.

(2) Make a study of the effect on the cost of maintenance of way and maintenance of equipment of fast trains.

(3) Make a study of the effect curvature has on the cost of maintenance of way.

(4) Make a study of the effect curvature has on the cost of maintenance of equipment.

(5) Make a study of the amount of fuel consumed in doing an actual horsepower-hour of work. It is believed that a study of this subject will not only be valuable as a basis in determining the economics of location, but that the results will be beneficial to operating officers, calling to their attention various losses in the fuel supply, and especially so in the cost of operating a very busy single-track vs. the cost of operating double-track lines.

(6) Preparation of a method for the comparison of alternative locations with varying ruling gradients.

CONCLUSIONS.

The following conclusions are submitted for approval:

(1) A line is located when its position is fixed horizontally and vertically.

(2) Locating a railway means designing an economical plant for handling a given traffic. The economical plant for a given quantity and class of traffic cannot be the economical plant for a greater or less quantity of traffic or for traffic of a different class. It is considered good practice to discount the future within reasonable limits, providing the necessary funds are available.

J. G. SULLIVAN,
Chairman Committee on Economics of Railway Location.

(3) The most general formula for the economic value of a location is:

$$\frac{R - E}{C} = p \text{ .... (1)}$$

Where R = Annual revenue (receipts from operation);
E = Annual expense of operation, including depreciation and taxes;
C = Capital invested (cost of construction);
p = Percentage of profit on investment.

(4) The following equation may be used in certain cases, especially where the annual revenue, known or unknown, is constant:

$$R - (E + I) = P \text{ .... (2)}$$

Where I = Amount of interest on cost of construction;
P = Amount of profit (net corporate income).

When the revenue is constant the condition of equation (2) is that the sum of operating expenses, plus interest on cost of construction, shall be a minimum, and is convenient in many cases, but does not indicate the proportion of profit to investment. Care should be taken not to use too low a rate of interest. The ratio of profit to investment should be considered.

(5) In order to make an economical location of a railway, the engineer must know or make a reasonable assumption of the amount and class of traffic that the railway will be called upon to handle, the class of power and the approximate efficiency and cost of the fuel that will be used, the rate of wages that will be paid to employes, the cost of maintenance materials, and the rate of interest considered a proper return for additional expenditures involved in the improvement of the line for the reduction of operating expenses.

(6) One of the most difficult problems to be solved is the desirable length of engine districts, but the question is governed to such an extent by other considerations that no definite rule can be given. One of the necessary requisites for a terminal point is a suitable water supply for locomotives and for domestic use. It is desirable, where possible, that terminal points should be located on minor summits.

(7) Passing sidings and road water supplies should preferably be located on minor summits.

(8) If passing sidings must of necessity be located on ruling gradients, then such gradients should be compensated through and for a full train length in each direction from either end of the siding. The rate of compensation will be governed by the ruling gradient.

(9) In deciding upon the ruling gradient for each engine district, where different ruling gradients are contemplated for adjoining districts carrying approximately equal traffic, due consideration must be given to the breaking up of trains, which may be caused by the difference in ruling gradients. Where a fixed elevation is to be overcome, the development of distance to reduce the rate of ruling gradient is often a mistake, provided the ruling gradient of the shorter line is within reasonable operating limits. Where curvature and distance are introduced for the sake of ruling gradient reduction, line resistance, and thereby fuel consumption, is increased, as is also the cost of maintenance of way and equipment. Some of the benefits derived from a reduction of the ruling gradient are the saving in weight of locomotives to be lifted over the summit, train and engine wages and engine mileage reduced and the capacity of the track increased. Full advantage cannot be taken of the apparent train rating increase due to ruling gradient reduction on an engine district having a large percentage of grade at or near the proposed ruling rate, as in all probability, if this anticipated increase in rating is in direct proportion to the proposed reduction in ruling gradient, the required time for movement of trains over the engine district cannot be made. On crowded single-track lines a feature affecting train rating to a great extent is the loss of time at meeting and passing points; it, therefore, is necessary to estimate the train rating for any line as the tonnage that can be handled in a given time, due allowance being made for necessary stops.

In estimating the time required for trains to pass over an engine district, a speed curve and time card should be plotted. There is little increase of tonnage for local and fast freights, and none for passenger trains, to be credited to a reduction of the ruling gradient on lines with light, undulating grades.

In establishing a ruling gradient and determining the effect of it on future operating expense, due consideration must be given to possible future revisions of the line; thus, in comparing alternative locations, one of steep ruling gradient may appear more economical than another of low ruling gradient, but the situation of the former may be such that its revision would necessitate an abandonment of all or a large percentage of the location; while the application temporarily of a steep ruling gradient to the low-gradient location might bring the cost of the latter line within such limits that, considering future traffic, its construction would be desirable.

(10) In the construction of a line where the contemplated immediate traffic is small and the future traffic large, sharp curvature and steep temporary gradients, so situated as to be possible of reduction when justified by the traffic, may be advantageously introduced; a line being thus constructed which will provide for immediate requirements and which can be improved for future requirements at a reasonable expense. Before deciding upon such temporary expedients, care should be taken to compare the cost of the work ultimately to be abandoned with the interest saved on the extra cost of construction that would have been necessary to construct a line on the final location during that period in which the more expensive construction would appear uneconomical.

In the construction of temporary lines due consideration must be given to the location of station buildings, and these should not be located on portions of the line where revisions are contemplated, owing to the fact that if a receiving and delivery point for local traffic is once established, opposition from the public may prevent its removal. In the matter of terminal property the future requirements should be estimated for a longer period than is justified for the line between terminals.

(11) Momentum gradients, not exceeding that over which a locomotive loaded for the ruling gradient can handle its train in two parts if stalled for any reason in the sag, may be used to reduce construction cost without decreasing the train rating or the efficiency of the railway, and should be used where economy in construction cost is thereby effected, except at points where train stops or reduced speed, below the limit necessary to operate the gradient, are likely to be necessary. In the calculation of the lengths of momentum gradients the maximum speed of freight trains at the bottom of the sag should not exceed the speed limit for such trains on the engine district under consideration; and the minimum speed at the top of the grade, where the velocity grade adjoins an ascending grade of any considerable length, should not be less than 11 miles per hour. Where the top of the momentum gradient is at a summit, the minimum speed may be less than 11 miles per hour.

In fixing the grade line for any alinement, care should be taken to insert vertical curves at all grade-line intersections. Curves should be connected to tangents by spiral or easement curves of such length as to provide ample space in which to make the required superelevation, giving due consideration to future requirements of increased speeds.

(12) The location of terminal points, ruling gradient, and pusher gradients having been decided upon, the effect of the minor details of location, namely, distance, curvature and rise and fall, upon operating expenses may be determined approximately in the following manner: Alternative locations may be compared by distance, curvature and line resistance; the distance being the length of the line measured along the center line of the location; the curvature the number of degrees of central angle subtended by the center line of the track, and which may be divided into sharp curvature, necessitating a reduction of speed for trains, and ordinary curvature, which will again be subdivided into that increasing line resistance in both directions and that increasing line resistance in one direction only and line resistance which is the sum of the rolling resistance (or friction resistance), plus the resistance of gravity overcoming difference in elevation on up-grades, plus the resistance due to curvature, minus the energy of gravity on trains on descending grades, from which has been subtracted the loss of energy (or velocity head) due to the application of brakes. For purposes of comparison this item should be reduced to its equivalent in feet of vertical lift.

Friction resistance, under normal conditions, of warm weather, modern freight equipment, and speed between 7 and 35 miles an hour, may be obtained from the formula

$$R = 2.2\ T + 121.6\ C.$$

R = Total resistance on level tangent.
T = Total weight of cars and contents in tons.
C = Total number of cars in train.

This amounts to 4 lb. to 8 lb. per ton, depending on whether the cars are fully loaded or empty. This is equivalent to a rise of from 10 ft. to 20 ft. per mile. For mixed traffic a conservative estimate is, train resistance equals rise of 15 ft. per mile. Train resistance increases at lower temperatures, and at extreme low temperature may go as high as 30 lb. per ton for empty freight cars. However, in comparing different locations in the same country, it is deemed necessary to make comparisons for the ordinary conditions only. The resistance due to curvature may be taken at 0.04 ft. per degree of central angle.

(13) *Fuel Consumption.*—It is the unanimous opinion of the committee that the train-mile basis alone is not a reliable or correct method of estimating fuel consumption for comparative purposes. The following two methods are recommended: First, dividing the fuel consumed into the amount required for the movement of the locomotive alone, calculated on a time basis, for consumption in yards, roundhouses and sidings, and the amount required for the actual movement of cars, and this last amount can be computed as varying directly with the amount of work done. Second, calculating fuel consumption by means of the speed curve, calculating from this the fuel consumed by locomotives working, drifting and standing. These methods for calculating fuel consumption also lend themselves to the comparison of lines with varying ruling gradients.

(14) To determine the relative value of the minor details of location under consideration (curvature, distance, rise and fall), it is first necessary to decide upon a method of studying the effect of these factors on the cost of operation. The following method is recommended: Curvature increases resistance at the rate of 0.04 ft. per degree of central angle; it also affects the cost of maintenance of way and the cost of maintenance of equipment, but sufficient data is not available to warrant a conclusion as to the definite amounts.

Rise affects line resistance and time; the principal effect of eliminating rise will be found in the fuel account. It also affects the cost of maintenance of equipment and maintenance of track, but to what extent is unknown. It may be neglected in comparing alternate locations.

Distance affects train wages, line resistance, maintenance of way and maintenance of equipment. The effect of distance on line resistance will be found in the fuel account. The effect of distance on train wages can be computed on a direct train-mile basis. The effect of distance on maintenance of way is a more complicated problem on account

of the uncertainty as to the basis on which maintenance should be calculated. A fixed sum per mile to cover factors of maintenance that are more or less constant plus a rate for the equivalent ton-mile unit, using multiples for weights of engines and passenger cars, is correct in principle, but until such time as information is obtained as to the value of these multiples, this item may be calculated on a basis of a constant per mile plus a fixed sum per train mile. The effect of distance on maintenance of equipment, for comparative purposes, may be calculated on a train-mile basis.

(15) *Special Structures.*—The maintenance and operation of special structures must be considered on their respective merits for each location.

(16) Time will not in general constitute an important factor in the consideration of the minor details of location, but if the difference in time required to operate over alternative locations is of sufficient importance to affect the amount of equipment to operate the line, and consequently the annual charge for same, the earnings of the line, or the trainmen's wages through overtime, this item must be taken into consideration.

(17) In comparing lines of varying lengths, consideration must be given to the effect of distance upon revenue. Another item worthy of consideration is the fact that the reduction of distance in engine runs of less than 100 miles, which constitute the entire day's work for trainmen employed on same, may not reduce the amount of wages to be paid to such employes.

(18) The data in the Manual on the subject of "power" should be amplified and altered to the extent recommended by the sub-committee on Stokers and Superheaters so as to provide for the increase in coal consumption and tractive power due to these improvements.

John G. Sullivan (C. P. R.), chairman; C. P. Howard (Cons. Eng.), vice-chairman; F. H. Alfred (P. M.), R. N. Begien (B. & O. S. W.), J. F. Burns (L. & N.), Maurice Coburn (Vandalia), A. C. Dennis (Contr. Eng.), A. S. Going (G. T.), F. W. Green (L. & A.), L. C. Hartley (C. & E. I.), P. M. LaBach (C. R. I. & P.), Fred Lavis (Cons. Eng.), J. deN. Macomb, Jr. (A. T. & S. F.), C. W. P. Ramsey (C. R. R.), E. C. Schmidt (Univ. of Ill.), A. K. Shurtleff, H. J. Simmons (E. P. & S. W.), F. W. Smith (Contr. Eng.), Walter Loring Webb (Cons. Eng.), M. A. Zook (Interstate Commerce Commission).

The report was accompanied by reports of subcommittee 1, on Grades, Curvature, Rise and Fall and Distance, elaborating on conclusions Nos. 5 to 17, inclusive; subcommittee 2, on Economics of Railway Location, presenting additional information in support of its conclusion of last year that the equivalent ton-mile unit is the correct basis for a comparison of maintenance of way expenses and a discussion, upon which conclusions Nos. 1 to 4, inclusive, were based; and of subcommittee 3, which presented information on stokers and superheaters, compiled from the reports of the committee on Locomotive Stokers of the American Railway Master Mechanics' Association and on information furnished by 15 roads using automatic stokers. Based on this information, this subcommittee recommended that the Manual be revised as indicated in conclusion 18.

MINORITY REPORT.

The undersigned cannot agree with that portion of the report concerning the foot-ton method of calculating the fuel consumed referred to in Conclusions 12 and 13. The fuel consumed per indicated horsepower of work varies from about 7.7 lb. with locomotives working full stroke to about 4.75 lb. at its maximum efficiency at about 3.6 times the speed that it can maintain full cutoff. The indicated horsepower at maximum efficiency is also over 60 per cent more than at full cutoff.

With these two facts in view it appears that the amount of coal per 1,000 foot-tons will vary widely. Another factor, however, enters into the work done by the locomotive, and it may or may not be a considerable percentage of the total work. This factor is the power exerted in accelerating trains which will vary from less than 1 per cent of the total power used on heavy gradients to more than 20 per cent on level grades, depending on the distance between stops. No notice is taken of this factor in the method set down in the report of the committee, and yet it is liable to add considerably to the total foot-pounds.

In a table were shown data from simple cases of three stations ten miles apart on a tangent, and a train starting at one end of the line and working at its maximum power on level and ascending grades, but stopping at both the other stations, using brakes for the last 1,500 ft. of stop. There is one exception to this: on descending grades, the train accelerates by gravity to 35 M. P. H., then is held at this speed to the foot of the grade, and then drifts to within 1,500 ft. of the station where brakes are applied.

The four separate cases are: (1) A level grade the entire distance. (2) A level grade for one-half mile; 9 miles of ascending 0.4 per cent grade; a level grade for one mile with station stop in it; 9 miles of descending 0.4 per cent grade, and one-half mile of level grade. (3) Same as (2), except 0.7 per cent grades are used instead of 0.4 per cent. (4) Same as (2), except 1.0 per cent grades are used instead of 0.4 per cent.

There is no question which of the above would be the most economical to operate. The whole idea of using the above is to illustrate the fallacy of using the foot-ton method in calculating fuel.

As tables covering the distances used in acceleration and retardation on the various gradients had been worked out for a consolidation locomotive in an article "Locomotive Fuel Consumption and the Speed Diagram," pp. 3 to 20, Part 2, Vol. 14, American Railway Engineering Association Proceedings, the same engine and train were considered here.

	Weight.	Resistance.
Locomotive	173 tons	2,450 lbs.
Train	1,306 tons	7,052 lbs.
Total	1,479 tons	9,502 lbs.

Average resistance per ton-train .... 6,425 lbs.
Equivalent grade resistance .... 0.3125 per cent

From the table which was prepared it was shown that the coal used per 1,000 foot-tons varies from 6.20 to 8.03 lbs. Taking the difference in foot-tons and the coal used for the various lines, we can get still wider results as follows:

Line.	Foot-Tons.	Lbs. Coal Used.	Lbs. Coal Per 1,000 Foot-Tons.
1.0 per cent	959,185	7,703	
0.7 per cent	748,339	4,914	
	210,846	2,789	13.23
0.7 per cent	748,339	4,914	
0.4 per cent	537,492	3,163	
	210,846	1,751	8.30
0.4 per cent	537,492	3,163	
Level	487,634	3,054	
	49,858	109	2.19

It is rightly claimed that we cannot be exact, owing to variables that enter into consideration of the subject, but we can be more exact than the foot-ton method of calculating the coal, as there is absolutely nothing to use as a base per 1,000 foot-tons. The above shows that you can figure it from various angles and get a maximum of over tix times the minimum. The simplest method and the one of greatest accuracy is by calculating the time of engine working and the time drifting and multiply this by the fuel consumed per hour working and drifting.

In the second paragraph of Conclusion 9 of the committee's report it is proposed to plat a speed diagram of the line. To do this the economical thing to do is work up tables, such as are shown on pp. 16 to 19 of the article on "Fuel Consumption" referred to above, for the assumed train on the maximum grade. This can be worked up in a diagram for convenience of the fieldmen. In order to expedite the work, time diagrams can be worked up covering the time consumed on the various grades in passing from one speed to another. With the speed diagram, however, it is simple to calculate the time.

Furnish the locating engineer a set of the tables or a diagram covering the information contained therein, and in comparing two alternate locations it is a small job to get very approximately the difference in coal used. He cannot get it by the foot-ton method except by chance. As has been shown, it is not a question of getting the average of minor variables, but trying to get an average of something which may vary over 500 per cent, depending on the way the thing is figured. There is no average.

With the above points in view the undersigned recommend the following changes in the conclusions as shown in the report:

Insert in Conclusion 12, after the first paragraph:

"The above method must be understood to not take into account the resistance due to accelerating trains. This may or may not be a considerable part of the total resistance, depending on the rate of grades and the distance between stops."

The next to the last sentence in Conclusion 12 should be changed to read:

"In comparing different locations, the resistance under average conditions should be used."

Conclusion 13, take out the last sentence and insert:

"It should be understood that the first method does not give information as to actual fuel consumed.

A. K. Shurtleff, Maurice Coburn, Vandalia; J. deN. Macomb, Jr., A. T. & S. F.

Discussion of Economics of Railway Location.

The report was presented by Chairman Sullivan, and the conclusions were considered individually.

L. C. Fritch (Can. Nor.): It does not seem to me that the statement in Conclusion 2 will hold good where it says: "The economical plant for a given quantity and class or traffic cannot be the economical plant for a greater or less quantity of traffic or for traffic of a different class." I suggest eliminating it entirely.

Chairman Sullivan: We will change it to read, "It may not be the economical plant."

Mr. Fritch: That covers the point.

E. J. Benzler (West. Church Kerr & Co.) presented a written discussion on Conclusions 3 and 4 which was summed up as follows: First, the problems of railway economics should not be complicated by the introduction of methods of financing. Second, formulas (1) and (2) give identical results if based on the same premises. Third, for a determination of economic value of a new line the most useful formula is one which shows the ratio of investment to surplus available after payment of operating expenses and interest on investment. Fourth, for a determination of economic values of alternate lines, including relocations, where revenue is not affected, the problem is simply to find on which line the sum of operating expenses and interest on investment is a minimum. Where revenue is affected, that line is best on which revenue less sum of operating expenses and interest is a maximum. Fifth, to get a proper basis for comparison it is necessary that the assumed traffic, conditions as to quantities of business handled, speed and length of trains, and other factors are consistent with the estimates of cost of line and equipment.

C. P. Howard (Con. Eng.): This equation (1) is simply a statement of the fact that the general formula or basis of comparing lines is that the ratio of profit to investment shall be a maximum. It is necessary to have some basis on which to compare different lines. Sometimes the other view is taken, represented by equation (2), that the sum of fixed charges to operating expenses shall be the minimum. The latter consideration does not take into account the ratio of profit to investment, and might be misleading in some cases, so it was concluded that the first statement should be the most general form of comparing an investment, that is, the ratio of profit to investment should be the maximum.

G. J. Ray (D. L. & W.): I think there should be something in Conclusion 5 in regard to traffic. Is the committee willing to have the word "direction" inserted after the word "amount" on the second line, so that it will read, "a reasonable assumption of the amount, direction and class of traffic," etc.?

The President: The committee will accept that suggestion.

Mr. Fritch: It seems to me the committee should give a definite rule for the length of engine districts in Conclusion 6.

Chairman Sullivan: That is one of the things that we paid as much attention to as any other. We knew it was no use to put in the mileage, as the association would not agree on proper mileage distance for a sub-division.

A. S. Baldwin (I. C.): I would suggest the following: "That the district shall be sufficiently long to avoid constructive mileage and short enough to enable the maximum slow freight train to make the run within the hours of service required.

The President: The committee is willing to accept that suggestion.

F. W. Green (L. & A.): Does Mr. Baldwin's suggestion carry with it the implication that there is a disposition on the part of the railroads to go the full 16 hours?

The President: Mr. Baldwin did not include any reference to sixteen hours in his suggestion. If there is no objection the substitute will be accepted.

Mr. Fritch: Nothing is said in Conclusions 7 and 8 about not locating passing sidings on curves.

Chairman Sullivan: I think possibly that was an oversight. We have in all of our instructions said that stations will not be located on curves; in fact, we are not doing it where we have a chance, and especially that no obstructions shall be placed on the inside of curves.

Mr. Baldwin: I would think that the gradient "should be compensated for a full train length, in either direction, from either end of the siding," is excessive. I have had experience on long maximum gradients, where it is exceedingly difficult to get a curved gradient compensation, and it is not necessary to have compensation for the full length of the train. There is only a small part of the train on the switch and the approach, and a much shorter compensation is sufficient than with the full length of the train.

H. R. Safford (G. T.): Is that not an erroneous use of the term "compensation"? Compensation really refers to compensation for curvature.

Chairman Sullivan: The committee will accept your suggestion.

The President: The former suggestion has not yet been passed on by the committee, the one in regard to carrying the compensation beyond the end of the sidetrack.

Chairman Sullivan: There is a great deal in what Mr. Baldwin states. This, of course, is the ideal condition, if you can get your sidetrack on a lower rate of grade, and for a full length at either side, say when you pull the train in going uphill; it is an ideal condition. Personally, however, I don't know that it is of a great deal of use, because when you are building a line at first you will probably have your stations ten miles apart, and later you will put in sidings; you cannot compensate at one point, and you must lower accordingly.

C. Frank Allen (Mass. Inst. Tech.): As I understand the purpose of the committee it is to meet this condition, that the train resistance at starting is probably fourteen to eighteen pounds per ton. The train resistance after you get going is more likely to be five pounds per ton. If I understand the purpose of the committee it is to reach that condition and not the curve of the siding or anything else.

Chairman Sullivan: That is true, of course, but at the same time your engine is more efficient; it can pull a greater load. We can start the trains usually on any grade, if they have not frozen up; but it is an aid to operation.

Mr. Baldwin: I wish to reiterate that I am not opposed to the reduction of the gradient through the sidetrack, but I think to make it a full train length, each side of the switch is too long, because it is adding a large amount to the cost.

The President: Will Mr. Baldwin accept the words "preferably for a full train length?"

A. S. Baldwin: Yes.

Mr. Fritch: That first clause of No. 9 is beyond my comprehension. We try to get all the tonnage we can on our local freight trains and our fast freight trains, and I think it is quite an important element in regard to those trains; and also as to passenger trains. There may be a case where we have a limit on passenger trains up to the time of double headers.

Mr. Baldwin: I concur with Mr. Fritch on that. An essential requirement in the study of that problem is the determination of what increase will be had in the rating of not only your dead freight trains, but your manifest freight and your local freight, and each of these is a problem to be considered on its own basis, and I think it should not be dismissed with the mere statement that but little increase in tonnage can be looked for. I would suggest that the clause be made to read, "the prospective increase in tonnage rating for local and fast trains should be given careful consideration." There are times when we can get a great deal of benefit in that class of traffic by a reduction.

Chairman Sullivan: I think Mr. Baldwin is probably right and justified in his conclusions, because we do give credit to the reduction of the ruling gradients. I think that should be struck out. It really is not a ruling gradient. It should be a reduction of gradients.

Mr. Baldwin: I have seen occasions where a reduction in gradient did not help the manifest freight a particle. Again I have seen where you had a steady manifest business, you got a proportion of increase in tonnage in the manifest trains, the same as in the dead freight, and I have seen where local freight trains have handled a large amount of tonnage that they did not handle before, and you got a large amount of credit in that in figuring the expenses. I think this dismisses the problem too lightly.

Chairman Sullivan: Mr. Coburn has written a letter objecting to the words "location of station buildings," and suggesting stations, meaning to include all buildings and track in Conclusion 10, which the committee will accept.

Mr. Ray: You state in Conclusion 11 that "momentum gradients, not exceeding that over which a locomotive loaded for the ruling gradient can handle its train in two parts, if stalled for any reason in the sag, may be used to reduce

construction costs," and later in the fifth line you say, "should be used where economy in construction cost is thereby effected." I think there are exceptions to that rule. Certainly it would be a bad thing to do on a railroad where traffic is so heavy that you could not have trains cut in two in the sag. I suggest that we add to that paragraph the words, "and except where traffic is unusually heavy." I don't think that should be a positive statement.

Chairman Sullivan: You are objecting to the use of velocity grades at all where traffic is heavy?

G. J. Ray: No, I say where traffic is heavy you could not afford to cut the trains in two at the bottom of the sag.

Chairman Sullivan: We mean if we are broke in two or flagged and stopped there. I am afraid we can't accept that. That is an economic question that will have to be figured out in detail for each position. If you can raise twenty feet rather than take a cut five miles long, twenty feet deep, or a fill back of that six miles long, twenty feet high, and you have double track, which you might have in that kind of construction, I fail to comprehend how heavy the traffic would be to warrant you in not putting in a momentum grade.

A. K. Shurtleff: The committee's report has entirely neglected one item of resistance, that is, the resistance overcoming acceleration. This may or may not be a large per cent of the resistance in some cases. It will be 20 per cent of the total resistance overcome between two points, in some cases; in other cases it will be only one per cent. I can't see how it is going to compare two lines without taking into consideration the acceleration resistance. In this same conclusion there is a repetition of a previous conclusion. They are speaking of the formula. If it is as stated, it may be obtained from the formula as given in the Manual, they can do away with the giving of the formula here.

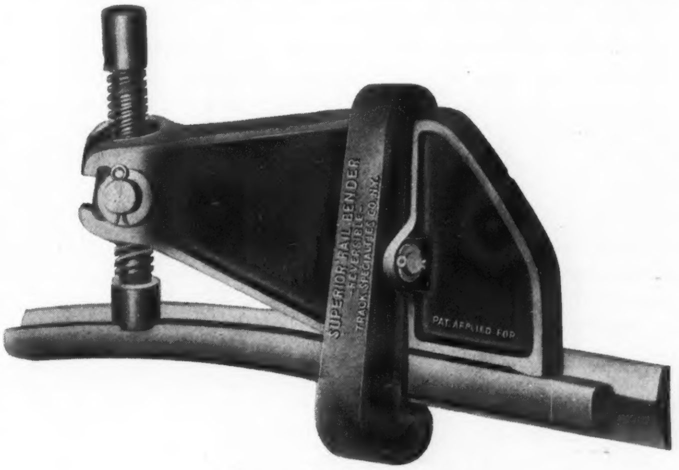
Chairman Sullivan: Answering Mr. Shurtleff, what he says about the formula is true. This is the formula adopted by the association. When this was written up by Mr. Dennis, Mr. Ramsey and myself it was thought that at that time we would make this report take the place of a good deal that was in the Manual; there was no idea of taking the credit for this formula away from Mr. Begiem and Mr. Shurtleff, who had worked on it in previous years. Answering Mr. Shurtleff's question regarding acceleration; acceleration can be taken into consideration, if necessary. If you are going to run your trains at 25 or 30 m. p. h. you know the velocity head; you know that you have spent that much energy to get it up to that velocity, but in comparing the minor details between the different points, if you go to that refinement, you have it for today, but you don't know how many trains you will run tomorrow, how many stops you will make, or what the conditions will be; but I think we are safe in assuming that they will be usually about the same on this line or that line, the two alternate lines that are under comparison. What we are aiming to get is a value for the resistance that we can eliminate, and are not trying so much to find out the exact economy of operation or how much coal we are using in operating the line in this problem. The committee is willing to insert in Conclusion 12, after the first paragraph, the following matter: "The above method must be understood to not take into account the resistance due to accelerating trains. This may or may not be a considerable part of the total resistance, depending on the rate of grades and the distance between stops."

We are also agreeable to changing the next to the last sentence in Conclusion 12 to read as follows: "In comparing different locations, the resistance under average conditions should be used."

Mr. Churchill: I want to ask one or two questions in order to bring out some information. The committee reports that they have assumed $200 a mile per year as a saving in eliminating distance. I do not see how they could get such a low figure as that. I believe when everything is taken into account we shall have to assume a minimum of not less than $600. The most recent case I had to do with in estimating these costs was in the study of the practicability of the electrification of a certain district. We got nowhere until we took the logs of every engine, the time consumed and the stoppages on every portion of the 30 miles. To my mind that is the only way to get at anything like true results. On page 116 of the report the statement is made with regard to the effect of minor details on operating expenses, that nothing is known, particularly, about what the effect of curvature is. I obtained from the Pennsylvania Lines West quite a long time ago some figures on actual results secured on wear of rail on curves, and turning these figures around in this form, after having added some information obtained on our own road, it is like this—if the life of the rail on the straight track is taken at 1.00, on a two degree curve it will be 0.90; on a two degree to four degree curve, 0.71; on a four degree to six degree curve, 0.66; on a six degree curve, 0.56; on a nine degree curve 0.33. There is a basis for determining what you can contribute to the rail wear on different degrees of curvature on the same kind of study. I will send this data to the committee.

THE "SUPERIOR" RAIL BENDER

A rail bender which combines in one device the right and left hand tools commonly used for bending rails has recently been placed on the market by the Track Specialties Company, New York, and is in use on several roads. The construction of this bender is clearly shown in the accompanying illustration, the principal features being the reversible yoke and the swivel collar through which the screw passes, serving to keep the screw always in a perpendicular position to the rail, thus eliminating the possibility of fracturing the casting.



A Reversible Rail Bender.

THE NICK-AND-BREAK TEST

The recent order for 35,000 tons of rails placed by the Illinois Central with the Algoma Steel Company, with specifications covering the nick-and-break test for every ingot has created a great deal of interest in this test. Although this is included in the rail specifications of the American Railway Engineering Association, many railway men are unfamiliar with its requirements. For this reason the following is an abstract of this portion of the specifications, as included in this order:

DESTRUCTION DROP TESTS

(a.) The test pieces from heats which have been accepted under the drop test requirements, and also the crop end representing the tops of all other "A" rails in each heat shall be nicked and broken. If the fracture shows no interior defect, all the rails of the ingot represented by such "A" rail end shall be accepted, but if the fracture shows interior defect the "A" rail of each ingot shall be rejected, and a test piece cut from the bottom end of this "A" rail. This piece shall be nicked and broken and if its fracture shows no interior defect, the "B" rail and the remaining rails of that ingot shall be accepted, but if it shows interior defect the "B" rail shall be rejected, and a test piece cut from its bottom end to be similarly tested for the rejection or acceptance of the "C" rail, and so throughout the rails of any one ingot as far as necessary to get sound steel.

(b.) The words "Interior Defect" shall be interpreted to mean seams, pipes, laminations, cavities, cinder or interposed foreign matter, or a distinctly bright or fine grained center evidencing segregation.

C. W. KOUNS HERE

C. W. Kouns, general manager of the Atchison, Topeka & Santa Fe, Topeka, Kan., spent yesterday afternoon at the convention and the Coliseum exhibits.

Operating Results of Steam Railroad Electrification

A Resume of the Present Status of This Development from the Standpoint of the Engineering and Operating Officers

A large number of the members of the American Railway Engineering Association attended the meeting of the Western Society of Engineers last evening. The subject "Operating Results of the Electrification of Steam Railroads," was selected with special reference to this convention, and the papers and discussion were confined to features of interest to the steam railroad engineering and operating officers, to the exclusion of the somewhat technical details more commonly discussed. The rooms were crowded, the meeting being one of the largest in the point of attendance in the history of the society. George Gibbs, consulting engineer of the Pennsylvania and the Norfolk & Western, and Edwin B. Katte, chief engineer, electric traction, New York Central, spoke and papers prepared by W. S. Murray, consulting engineer of the New York, New Haven & Hartford, and C. A. Goodnow, assistant to president, Chicago, Milwaukee & St. Paul, were also read, the latter two gentlemen being unable to be present. An abstract of the papers and discussions follows:

RESULTS SECURED ON THE NEW YORK CENTRAL

By EDWIN B. KATTE,

Chief Engineer Electric Traction, New York Central; New York.

The most interesting thing about electrification to railroad men at the present time is the first cost, and here the comparison with steam operation is most unfavorable. For example, a modern steam locomotive costs about $25,000, and an electric locomotive of the same capacity costs, say, $45,000. That is not all. The cost of the power station, transmission lines, substations and working conductors must be added, which will bring the equivalent cost up to about $110,000, more or less, depending upon the system adopted and the character of the service. Hence, there should be a large saving in operating costs to cover the increased fixed charges, or there must be some other good reason for incurring the additional expense.

The New York Central electrified its lines into Grand Central Terminal because it had a bad four-track tunnel condition to deal with at the most congested point of traffic. After electrification was decided upon, a very comprehensive scheme of improvements followed, which has cost in all something like $120,000,000, resulting in radical changes in the movement and operation of trains. It is for this reason that a direct comparison between the former steam and the present electric operation is impossible. However, some general comparisons can be made, based upon rather broad assumptions.

The average cost per locomotive mile, derived from a large number of records of steam locomotives in all classes of service, has been found to be about 26 cents, including fuel and supplies, maintenance, repairs and engine house expenses. A similar figure for electric locomotives operating in and about New York City can be shown to be about 21 cents, but when fixed charges are added the comparison becomes 30 cents for steam locomotives and about 60 cents per mile for electric locomotives. This comparison is only approximate and open to criticism, because of the fact that conditions in New York permit but an average of 85 miles per day for electric locomotives, while the steam locomotives are averaging about 150 miles per day. Further, many assumptions, too numerous to describe in this brief discussion, were necessarily made which would preclude the acceptance of these figures as a direct comparison of facts, but are sufficiently accurate to indicate the tendency.

The electric locomotive service in New York and vicinity includes switching in yards and terminals, hauling shop trains about six miles, and a main line express service on one division of 34 miles and another division of 24 miles. The average cost for maintenance, including inspection, repairs, renewals, cleaning and painting, varies from month to month, but the average, covering a period of eight years, is not far from 3½ cents per mile. The maintenance during the past year has been about 4⅓ cents per mile. The increase was caused by the renewal in one year of driving wheel tires on the first 35 locomotives purchased.

The suburban service in the vicinity of New York City is handled by multiple unit trains, consisting of from two to eleven cars, with trailers used in the proportion of two motor cars to one trailer on trains having easy schedules. Maintenance, including mechanical and electrical repairs, inspection, renewals, painting, etc., excluding only sweeping and window cleaning, has averaged somewhat less than 2 cents per car-mile.

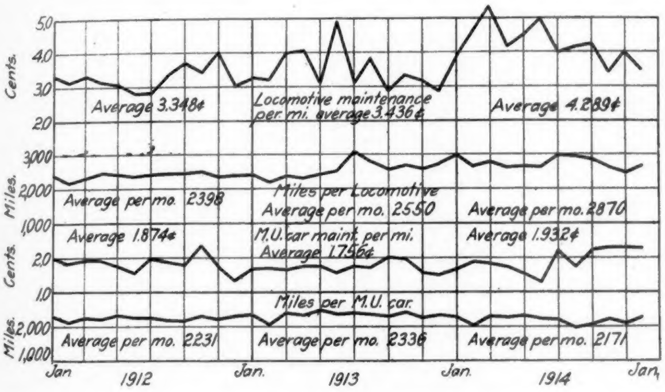
Modern Electric Locomotive of the New York Central.

The working conductor used by the New York Central is a special type of underrunning third rail, and is believed to afford greater protection from accidental contact than any other third rail. Its chief characteristics are, first, a wooden sheath enclosing the live third rail, except at the bottom or contact surface, and second, an insulated support, so hung as to afford flexibility to prevent strains due to the up and down movement of the supporting ties under traffic. The cost of maintaining this protected third rail is naturally higher than for the usual type of third rail, and the large amount of construction work in progress adjacent to the third rail has increased the maintenance

cost above normal conditions. The average cost has been about $26 per mile, per month, on the main line and $40 for yards and terminals, including track bonding and cable connections, both positive and negative.

The cost of maintaining the New York Central Railroad's cable system can be of little comparative value, because of the great diversity of its character to meet unusual local conditions. Lead-covered, paper-insulated cables are used in underground tile ducts. Steel-wrapped, varnished-cambric cables are used in iron pipes on the Park Avenue viaduct; armored, lead-covered, rubber-insulated cables are laid under the Harlem river, while bare copper, aerial cables, supported on steel poles, are used in the outlying and less congested districts. However, as a general statement, it may be said that the cost of maintaining the three-phase A. C. lines is about $8 per circuit mile per month, and the direct current cables cost about $13 per cable mile.

The cost of electric current varies considerably with the prices paid for coal, which in New York average from $2.50



Operating and Maintenance Cost of Electric Locomotives and Multiple-Unit Cars. Also Average Miles Per Month Per Electric Locomotive and Multiple-Unit Car on the New York Central.

to $3 per short ton. Also the fact should be noted that power stations in the vicinity of New York City are operated on three 8-hour shifts in place of the more common 12-hour shifts. Eleven thousand volt, three-phase, 25-cycle current measured at the busbars of the Port Morris power station averages between 0.45 of a cent and 0.50 cent per kilowatt hour for operating labor and materials. When fixed charges are added, the cost averages about 0.75 cent. The transmission of current to the substations, transforming in substations, the loss in the working conductor system, and adding all fixed charges will bring the average total cost of current delivered to the shoes of equipment, to about 1.75 cents per kilowatt hour.

As a measure of the reliability of electric equipment, a comparison of the locomotive or car miles per detention is preferable to a comparison of the miles per minute detention, since the former excludes delays to following trains and other causes of delay in no way contributed to by the equipment. During the year 1914 the average locomotive miles per detention was 22,000, while the multiple-unit cars averaged 51,000 miles per detention. The train-minute delays due to electric power troubles totaled 840 minutes for the year. The aerial lines contributed most largely, namely, 535 train-minutes; the third rail caused 244 minutes' delay, substations 25 minutes, and the power stations have never caused a minute's delay during their eight years of operation.

The electric locomotive shown in the illustration is the latest type used by the New York Central in express passenger service. It has a speed of 60 miles per hour when drawing a 1,200-ton train. All axles are equipped with motors, each having a continuous capacity of 250 h. p., or 330 h. p. on the one-hour rating, that is, 2,640 h. p. total. The locomotive is equipped with an oil-fired, flash type boiler having a capacity of 2,000 lb. of water per hour for heating through trains. The complete weight of the locomotive is 132 tons, all of which is carried on the drivers, thus giving a drawbar pull of 66,000 lb., assuming 25 per cent adhesion. The multiple-unit cars are of all-steel construction, 60 ft. long over buffers and weigh about 57 tons. They seat 64 passengers each. There is one motor truck under each motor car, having two motors of 200 h. p. each. The maximum speed of the train is 54 miles per hour.

THE ADVANCE OF ELECTRIFICATION

By W. S. MURRAY,

Consulting Engineer, New York, New Haven & Hartford; New Haven, Conn.

We are rapidly putting far behind us the days when the attitude of railroads was to sit by and watch some one or two other railroads experiment with electricity as a motive power. Indifferent interest has given way to the realization that these pioneer roads who have been using this new power in every form of railroad movement have developed a fund of data which entitles electrification to more than passing interest, and requires that the other roads be keenly alive to the possibilities it may hold out in the matter of betterments to their own property.

That a thing of any character has the right to live and improve is based entirely on whether it is founded on correct principles. In the early days, when electrical movement was first introduced on heavy traction railroads, theory was strong and practice severely limited. The guiding principle upon which electrical men based their opinions that electrification had its proper place in the economic world was that by its use certain savings could be effected that would justfy the investment necessary to secure it. There was entirely outside of this, but indirectly an economic factor, the advantage accruing to the passenger in the form of a clean ride.

While I have, of course, been keenly interested in electrification that has been applied to other railroads, naturally the past 10 years' association with the New Haven work, during which time over $15,000,000 have been expended in this department of betterment, has brought the real elements of its progress within very close range.

In June, 1914, the first New York, New Haven & Hartford passenger train was operated from Grand Central Station to New Haven over a four-track electrified route of 73 miles in length. Between New York and New Haven, measured upon a single track basis, there are some 500 miles of electrified line, of which 184 are included in yards and sidings. On these tracks to-day, every class of passenger, freight and switching movement is made, and electrical statistics are kept of all power house, line or equipment failures, a reference to them suggesting the features of electrical operation that requires first attention for the betterment of service.

A feature of electrification which at present is the most appealing to one who has given the subject some consideration, is in the matter of freight and switching movements. Since 1907 the New Haven road has been operating its regular 100 per cent electric passenger service between Stamford and New York. But recently, experience with regards to electric movement in switching and classification yards, and more recently that with regard to freight movement on main line track, has indeed been a revelation in the possibilities of heavy electrical traction. For example, during the month of January past, on the New Haven over 40,000,000 ton-miles trailing load were handled by electric locomotives, this total tonnage being made up of fast, slow and local freight movement. Wattmeters are installed on all of the electric engines to register the kilowatt hours of consumption. Records of these wattmeters indicate that fast freights require about 34 k. w. hours per train mile; slow freights about 60 k. w hours per train mile; local freights about 36 k. w. hours per train mile, these figures being for trains varying in tonnage from 1,000 to 3,000 tons.

Of interest also are the kilowatt hours per 1,000 ton-miles of trailing load. For fast freight the kilowatt hours per 1,000 ton-miles are about 30; for slow freight 30; and for local freight 85. I mention these figures only to illustrate this new and vast sum of information that is daily coming to us. The "watt hour constants" are of necessity average figures, made up of trains having varying weights and schedules, and yet the records from which they are taken admit of instant segregation into any class of service for which a constant is desired. The question that might be asked in looking at these constants is: What do they signify? And the answer is brief. An electrical ton-mile as against a steam ton-mile reduces the coal pile in a ratio of 1:2.

While our present freight movement by electricity on the main line is to-day limited both on account of the general depression in business, together with the fact that a full complement of electric freight locomotives is not yet at hand, there is no question in my mind but that the greatest returns to be secured by electrification will be through freight movement. While in the past we have appreciated the economies to be secured through electrification, by virtue

of the lesser expenditures required in fuel and maintenance of electric engines as against steam, there is fast coming to the front what might be called a more visualized economy in the reduction of expenses by effective savings in train miles.

Illustrative of the economic value of a "kilowatt hour" in its application to an electrification system, I quote from a part oi a recent letter which had reference to the utilization of some 4,500 k. w. of demand in connection with its application to the eastern section of our electrification zone. I would particularly draw your attention to the item of $49,275, which has reference to the economies to be gained by the double heading of freight trains operated between Harlem River and New Haven. This economy, and its automatic complement, the increase of track capacity, are the phases of electrification that are striking deep into the consideration of the steam operating railroad man.

"(1) The extension of the station contemplates, as you know, supplying a maximum single-phase demand of approximately 4,500 k. w. This amount of power, measured by train units, would permit the operation of 12 additional daily trains in fast freight service of average tonnage or its equivalent in any other class of service between Harlem River and New Haven.

"(2) The number of kilowatt hours which would be consumed by the above 12 trains would be 17,500 k. w. h. annually, and, upon a coal ratio of 1 to 2 in electric and steam service and a basis of 3 lb. per kilowatt hour and $3 per ton, an annual saving to the railroad company of $78,750 is indicated.

"(3) Further translating the above movement into engine miles, our log sheet records indicate that the number of engine miles required for the above movement would be 990, which, multiplied by the difference in cost of engine repairs at five cents per engine mile, effects an annual saving of $18,250.

"(4) The transfer of 12 daily trains from steam to electric service will permit a further extension of our present practice of 'double heading' trains in electric service, thus saving 450 daily train miles, which, as shown by our log sheet, will secure an annual reduction in train wages of 30 cents per train mile, corresponding to an annual reduction of $49,275.

"(5) A supply of approximately 3,000 k. w. (average) to the New Haven end of the line will effect a further saving of $16,500 in transmission losses, as compared with the transmission losses of the same amount of power from Cos Cob Station, the above savings being based upon the conservative cost of 5 miles per k. w. h. In explanation of the apparently large value of the saving in transmission losses to be effected by this small installation, it will be evident that its value is a maximum when applied at the extreme end of the transmission system.

"(6) No tangible values can be assigned for the very important effect upon the regulation in line voltage at New Haven, which will be reflected in the cost and efficiency of operation in many ways.

"(7) The summary of the total savings as above which will be effected is as follows:

Fuel	$78,750
Engine repairs	18,250
Engine and train wages	49,275
Transmission losses	16,500
	$162,775"

If any criticism can be placed with regard to the matter of freight movement by electricity, I would say it would be in the matter of speed. The electric freight locomotives of the New York, New Haven & Hartford were built on specifications that permitted them to operate 1,500-ton trains on level track at 35 miles per hour. While the speed element, in as far as the New Haven service is concerned, may be entirely justified, due to the very large ratio of passenger to its total service, thus permitting the freight trains to clear more promptly for passenger traffic, I would say that where the ratio of passenger service is less, the speed element for equal horsepower could be more valuably thrown into traction. For example, the New Haven locomotives have drawbar pull characteristics that permit the operation of 3,000-ton trains by double-heading. If these engines were reduced in speed by 35 per cent and their traction increased by the same percentage, 4,000 tons would be the resulting double-header trailing load, which in turn would effect a large saving in train miles, were these engines to be operated on a property less subject to passenger movement.

Much valuable information has been developed in the past two years in connection with the handling of classification and switching yards by electric motive power. An idea as to the reliability of this class of service may be gained in saying that in 1,000,000 electric switch engine miles there has been but one failure. The New Haven property includes in it two large switching yards; the Oak Point yard, containing 35 miles of track, and the Harlem River yard, 25 miles. The introduction of the electric engine in these yards has increased the speed of the yards very greatly, and, as nearly as I can gather from the yardmasters, this increase of speed has been secured with a ratio of electric engines to steam engines replaced varying between 4 to 6 and 6 to 10.

Electricity in trunk line territory is now on a plane of consideration entirely different from the earlier days, when it was new, untried, and problematical. The future will see its agency playing a most important part in railroad competition.

It would seem very inappropriate, with so good an opportunity as this, not to say a word or two as to "system." I am frankly willing to admit that I am a firm believer in the single-phase system for trunk lines, the governing element in which, from an electrical standpoint, has been the transmission system. In a rigorous determination to adhere to this principle as correct for such a field it has not been to gainsay the application of direct current in the territory where it rightly belongs, namely, where the governing element has been (mass trains under acceleration and braking in close headway) in translation. As a citation of the two examples, I would offer: (1) The electrification from New York to New Haven, and (2) the electrification of the New York subways.

In closing my address I would speak of two things which to my mind are most pertinent to the advance and successful utilization of electricity in the field of heavy traction. The first is with reference to the mercury arc rectifier, and the second is in regard to the effect of electrical administration on the railroads electrifying.

With reference to the mercury arc rectifier, I feel sure that it will be of interest to state that a car has been in commercial operation on the New Haven road taking power from the 11,000-volt overhead contact system, and converting it into direct current for application to its propulsion motors. This car has been giving a most successful service, and the problem of the production and maintenance of the vacuum tube, through the agency of which the alternating current is converted into direct current, has been electrically and commercially solved. What are the possibilities accruing from such a result? This can be epitomized in the statement that if the economies in the transmission system of the single-phase system justified the utilization of a heavier and less efficient motive power, to-day we are in a position not only to secure the economies gained in this transmission, but operate beneath the contact wires of such a system the more efficient and lighter direct current apparatus. As a concrete and practical application of this result, the present alternating current motive power now in use on the New Haven will be increased 25 per cent, by the application of the rectifier, and will also permit it to enjoy simultaneously transmission and motive power facilities of the highest order of efficiency.

With regard to administration, past experience with the engineering, construction and operation of a trunk line property of the character of the New Haven road has indicated forcibly the necessity of a very complete understanding of the difference between the operation of a steam and an electric property. In my judgment there will be no necessity for any general change in the administration or organization at present observed in steam operated properties to effect proper electric operation, but the fact should be impressed upon the minds of higher officials in the steam roads using or contemplating using this new mode of electric power that the methods pursued in producing a ton-mile of any character, passenger, freight or switching upon a steam basis must be abandoned when the drawbar pull comes from electricity. The error of holding a steam master mechanic responsible for an electric engine mile of any character is patent and the error is equally patent of holding a steam railroad shopman responsible for the maintenance and repairs of electric engines. Like electric power houses and transmission lines requiring the proper electrical talent the electro-mechanics inside and outside of the shop are essentially necessary to the success of proper maintenance and inspection of electric motive power. Such an arrangement does not change, but merely affects the splendid railroad organization and administration that has come down to us. A successful operating result after electrification has been applied is entirely dependent on a clear understanding and observation of this real difference between steam and electrical operation.

ELECTRIFICATION WORK ON THE MILWAUKEE

By C. A. GOODNOW,

Assistant to the President, Chicago, Milwaukee & St. Paul.

The Chicago, Milwaukee & St. Paul is now engaged in the electrification of that portion of its main line to the Pacific coast between Harlowton, Mont., and Avery, Ida., a distance of 440 miles. This project is of special interest because: (1) it provides for the electrification of four entire engine districts, and (2) this work is being done to effect economies in operation on a single-track line of moderate traffic and not to overcome congestion on a busy line now working to its capacity or to eliminate the smoke nuisance.

Between Harlowton and Avery this line crosses three mountain ranges, the Belt mountains at an elevation of 5,768 ft., the Rocky mountains at an elevation of 6,350 ft., and the Bitter Root mountains at an elevation of 4,200 ft. There are several tunnels, the longest of which is the St. Paul Pass tunnel at the summit of the Bitter Root mountains, 9,000 ft. long. The maximum grade westbound is 2 per cent for 20.8 miles on the eastern slope of the Rocky mountains, while the maximum grade eastbound is 1.7 per cent for 24 miles approaching the St. Paul Pass tunnel. The hardest problem of this nature, however, is presented by the continuous 1 per cent grade for 44 miles ascending the western slope of the Belt mountains, involving as it does the necessity for special precautions to avoid overheating the motors while working at their maximum capacities for this long period of time.

Besides the yards at Harlowton and Avery, intermediate terminals are now located at Three Forks, Deer Lodge and Alberton. These terminals are all small and with the exception of Butte and Missoula, there are no towns of any importance within these limits. There is therefore practically no breaking up of trains as all traffic is through business. Including these yards and side tracks about 650 miles of track will be electrified.

Power will be purchased from the Montana Power Company. Owing to the ample supply of water power available and the low cost of construction, the unusually low contract rate of $0.00536 per kilowatt hour has been secured. By contracting for its power the railroad thus avoids expending directly the large amount required for the construction of power plants. To minimize peak loads it is probable that the duties of the train and power despatchers will be combined. In this way the spacing of trains can be best arranged to keep the peak loads down to the minimum. With the traffic existing on this line it is expected that this can be done without serious interference with the operation of freight trains.

To minimize the dangers of interruptions to the delivery of power a tie-in transmission system is being built by the railway to permit feeding each substation from two directions and from two or more sources of power. The transmission line is being constructed with wooden poles, will operate at 100,000 volts and in most cases will follow the right-of-way.

The Montana Power Company will deliver energy to the line at seven points between Harlowton and Avery. On the engine district between Three Forks and Deer Lodge, on which work is now under way, three substations are being built to convert the 100,000-volt, 60-cycle, 3-phase alternating current to 3,000 volts direct current. This is the first direct current installation using as high a potential as 3,000 volts and was adopted after observing the results secured with the 2,400-volt, direct current installation of the Butte, Anaconda & Pacific, which parallels the ine of the St. Paul for a short distance west of Butte.

The trolley construction is of the catenary type with two 4/0 trolley wires flexibly suspended from a steel catenary and supported on wooden poles with brackets on tangents and flat curves and cross spans on the sharper curves and in yards. The twin-conductor trolley consisting of two 4/0 wires suspended side by side from the same catenary by independent hangers alternately connected to each trolley wire. This permits the collection of very heavy current by reason of the twin contacts of the pantograph with the two trolley wires.

Contracts were let last year for nine freight and three passenger locomotives for use on the first engine district, while nine additional locomotives were ordered early this month for use on the second engine division from Three Forks to Harlowton. The passenger locomotives are designed to haul 800-ton passenger trains at a speed of 60 miles per hour on the level or 35 miles per hour on a 1 per cent. grade and will be equipped with oil-fired steam-heating outfits for heating the train. The freight locomotives are designed to haul a 2,500-ton train on all grades up to 1 per cent. at a speed of approximately 16 miles per hour. This same train load will be carried unbroken over the 1.7 and 2 per cent. grades with the help of a second similar locomotive acting as a pusher. At the summits of the grades, provision is being made to run the pusher locomotive around the train and coupling it to the head end to assist in the electric braking on the descending slopes. In addition to providing the greatest safety in operation, this will also enable a considerable amount of energy to be returned to the trolley for the assistance of other trains and reduction in the power bill. The electric locomotives will have sufficient electric braking capacities to hold the entire train on the down grade, having the air brake equipment for use in emergencies or when stopping the train.

At the present time work is being actively pushed on the engine district between Three Forks and Avery, 113 miles, crossing the summit of the Rocky mountains, and it is expected that this will be ready for operation next October. Work is now also being started on the engine district from Three Forks east to Harlowton and it is planned to start work on an additional district each year until all four are completed. The contract with the electrical company provides that the entire 440 miles be in electric operation by Jan. 1, 1918.

Several important economies are expected from the electrification of this line. In the first place this is the first time an entire engine district has been electrified, permitting the complete substitution of electric for steam locomotives between the terminals. In other installations throughout the country only a portion of a division has been electrified resulting simply in a shortening of the steam-operated engine district. With the present schedules enforced with train employees this has not enabled the savings to be secured which will result from the operation of the entire engine district by electricity. Furthermore, with the electrification of four adjoining engine districts, it is planned to change locomotives only at the second terminal or at Deer Lodge. The crews will be changed at the intermediate terminals, Three Forks and Alberton, but there will not be the delay incident to the present methods of operation. It will be possible to abandon these intermediate terminals with the exception of a small amount of trackage on which to set out bad order cars, hot boxes, etc. It is also expected that with the low contract price for power which has been secured, a considerable saving will be made over the amount now expended for fuel. From these and other savings expected, it is anticipated that this expenditure will yield a very attractive return on the investment. If this is realized it is possible that electrification may be extended from Avery across the Cascade mountains to Seattle and Tacoma, a total distance from Harlowton of 850 miles, but not, however, in the near future.

ELECTRIFICATION WORK ON THE NORFOLK & WESTERN AND PENNSYLVANIA RAILROADS

By GEORGE GIBBS,

Consulting Engineer, Norfolk & Western and Pennsylvania.

The Norfolk & Western is an important trunk line with a large and diversified business. Especially important is its growing business in coal, both east and westbound. Eastbound from the summit of the Allegheny Mountains to tidewater, a distance of 375 miles, is the part of the road that we are especially interested in in connection with electrical equipment. The grade selected for electric traction is known as the Elkhorn grade in the Pocahontas coal region. The tonnage on the road is very heavy, and has doubled during the past four years. It amounts now to an average of 40,000 tons a day and has exceeded 60,000 tons. This produces a favorable condition for electric traction, as density of traffic has an important bearing on economies.

Another important consideration in the decision to electrify is the fact that the section selected is a gathering division, starting at Bluefield west of the Allegheny summit and includes about 30 miles of heavy grade along the western slope, including practically the entire gathering division for that particular Pocahontas field. This means that the division now is operated as a switching and gathering division by segregated class of power. Starting from Vivian eastbound, there are about 5.5 miles of one per cent grade. Then another 5.5 miles of 1.5 per cent grade, and then about 4 miles of 2 per cent grade, to the Elkhorn tunnel. Beyond the tunnel one descends a 2.5 per cent grade for about a mile and then encounters a 0.4 per cent ascending grade for about 9.5 miles. Finally there are 4 miles of 1.3 per cent grade into Bluefield where the Classification yard is located.

The trains over these heavy grades are hauled by Mallet

engines, three engines being required to haul the train at a speed of 7 or 8 miles an hour over the division. In the Elkhorn tunnel this speed is reduced to about 6 miles per hour.

The tunnel is of limited cross-section and difficulties with smoke have, therefore, been intensified. The tunnel has been equipped with Mr. Churchill's method of ventilation, which consists of an annular nozzle through which air is blown into the portal of the tunnel at a speed slightly greater than the speed of the train—7 miles an hour for a train running 6 miles an hour. Naturally, the fact that the tunnel is on a heavy grade and the space limited, and that it is a single track tunnel, makes it the neck of the bottle for the entire movement.

That line is a very crooked one, about 60 per cent of the entire division being curved with maximum curves running up to 12 degrees on the main line, and 16 degrees on the sidings. While the weight of the trains is 3250 tons now with Mallet service, the weight is cut down in winter time to as low as 2,900 tons in order to get the trains over the division.

A decision was arrived at about two years ago to electrify, and the matter was put in the hands of myself and partner as consulting engineers of the company to carry it out. It was apparent, in going over the line, which goes through a narrow valley, that it would be impossible to use a third-rail system, and that it was necessary to use some overhead system. That narrowed the problem to a consideration of the high voltage direct current and the high voltage single-phase system. A further analysis of the cost and other advantages of the latter system, resulted in the adoption of the single-phase system. That was of especial importance on account of the enormous power which we were required to apply to each train, meaning that the amount of current to be collected would be great at low voltage, and therefore that it was desirable to keep it down as low as possible by adopting the highest possible voltage.

In adopting this system a number of novel features were introduced especially in the type of locomotive. We bring the single-phase power to the locomotive, convert it into three-phase power and use it in three-phase motors. By this arrangement we obtained the advantage of a single overhead conductor, which advantage is great in complicated yards and on crooked lines. The three-phase motor is not adapted to other classes of railway service. It is essentially a one or two-speed motor. It is not suitable for main line service requiring very little speed, but it is eminently suitable for tonnage work on heavy grades, as it is a rugged type of electric motor. Without commutator and having characteristics we have not been able to obtain in direct single-phase motors.

When I say that it has one or two speeds, I mean that the speed of the train will be maintained, irrespective of the load and the grade at any speed at which the motors are set. If on going down grade the speed is exceeded by coasting, the train pushing the locomotive, the motors automatically return the current to the line at normal voltage and may be used in propelling trains up grade if there are any trains to propel. If there should be none there it is sent through steel combs which dip in the water and spill it over in the water.

For this service we had built and provided 12 locomotives, besides having three-phase motors that have some novel mechanical characteristics. Each locomotive is equipped with eight three-phase motors, arranged with four 8 and 4 pole combinations, to produce 14 and 28 miles per hour, respectively. The total length of the locomotive is 105 ft. over all and the diameter of the driving wheels 62 in. The Norfolk & Western locomotives weigh a total of 270 tons apiece, with 220 tons on the drivers. The drawbar-pull varies from 114,000 lbs. during acceleration at the 14-mile per hour speed, to 86,000 lbs. when operating at this speed uniformly on a one per cent grade, but on a recent test a locomotive developed a tractive effort in excess of 170,000 lbs., indicating, however, a coefficient of adhesion which cannot be assumed in practice. The maximum guaranteed accelerating tractive effort for a locomotive is 133,000 lbs. At the present time about half of this section of the road, including the entire heavy grade division, has been operating for about a month, and the experience we have thus far encountered indicates that our anticipations are to be realized in obtaining a remarkably successful installation. The trains accelerate promptly and without jerking on the heavy grades. On the 0.4 per cent grades we obtain a speed of 32 miles per hour with a 5,200-ton train behind the engine. On a 2.5 per cent down grade we are able to hold the trains at a speed not to exceed 14 miles an hour. As soon as the speed exceeds the 14-mile limit the current drops to zero, then mounts up in the opposite direction, and we return automatically to the line an amount of current probably in excess of 2,000 kw.

The acceleration of these heavy trains, as regards the amount of power required, is impressive. Our preliminary tests indicate a development of 11,000 hp. on one train during the acceleration period, and 8,000 hp. when running at uniform speed. I believe these figures are in excess of any amount of power delivered on steam locomotive trains anywhere in the world.

[This Norfolk & Western project will be described in detail in an early issue of the Railway Age Gazette. Mr. Gibbs concluded with a brief description of the electrification of the Pennsylvania main line between Broad St. Station, Philadelphia and Paoli, a distance of 20 miles. Only the suburban traffic will be operated electrically. This installation was decided upon solely to afford temporary relief for the congestion at Broad St. Station and it is not expected that it will yield any financial return on the increased investment. This project was described in detail in the Railway Age Gazette, June 5, 1914, page 1243.]

Discussion.

Chas. S. Churchill, assistant to the president, Norfolk & Western, presented the following details of the studies which prompted the electrification of the Elkhorn grade.

The Norfolk & Western started its investigation in 1905. The first reports were not favorable, but later studies showed a saving in coal consumption and an increase in capacity and in safety of operation of the line. A log record of all freight trains on the 30-mile district under consideration was kept for a considerable time, all locomotive repairs and other costs being detailed. With three Mallet locomotives pulling a tonnage train on a two per cent grade there are of necessity numerous delays limiting the steam locomotives to one trip a day. On the other hand, the electric engines can make two or three trips so that 33 electric locomotives are replacing 11 steam locomotives. The statement that the electrified line carries 60,000 tons per day is an indication that no lighter traffic would justify the expenditure.

J. C. Mock, electrical engineer, Detroit River Terminal, stated the general conditions under which the Michigan Central tunnel under the Detroit river is being successfully operated by electric power. This is strictly a terminal service between Detroit and Windsor, the trip for freight trains being about 4 miles and for passenger trains about 3 miles. The grades on the tunnel approaches are 2 per cent in one direction and 1½ per cent in the other, necessitating two electric engines on the head end of passenger trains and two on the front and one on the rear of tonnage freight trains. The first locomotives weighed 100 tons, but the latest order was for 120-ton units, the additional weight being required for the heavier passenger trains which had increased from 600-800 tons to 1,000 tons and more. The electric service now covers about 1,300 cars per day, including about 100 passenger cars, the total tonnage averaging about 50,000.

E. W. Herr, vice-president of the Westinghouse Electric & Manufacturing Company, called attention to the rapid progress made in electrification work in the decade since the introduction of the first heavy electric power and urged the necessity for careful investigation to justify any change from steam to electric traction in the best interest of the future development of the industry.

The subject was also discussed by E. H. Lee, vice-president and chief engineer, Chicago & Western Indiana, Judge Jesse B. Holdom and W. F. M. Goss of the Chicago Association of Commerce Committee on Smoke Abatement and Electrification of Railway Terminals, and B. J. Arnold, member of the Chicago Railway Terminals Commission.

THE HUNT "SPECIAL" RAIL INSPECTION

The "special" inspection of the manufacture of steel rails under which continuous inspection is maintained at the open hearth furnace, or Bessemer converter, the blooming mill, the rail mill and the drop test machine was inaugurated by Robert W. Hunt & Co., Chicago, in April, 1912. A number of the larger roads soon availed themselves of the opportunity to secure this service, so that during the year 1913, 70 per cent of all rails inspected by this company were given the "special" inspection, and in 1914 this figure increased to 78 per cent.

Before the inauguration of this system, the inspection of rails by this company followed general practice covering such mechanical standards as section, weight, length, straightening, sawing and finishing of the ends, drilling of the holes, etc., in addition to an examination of all rails for the appearance of flaws and physical defects, such as pipes,

seams, laps and other conditions made manifest by the drop test. Necessarily much of the work of an inspection of this character was limited, for as mill work proceeds both day and night, while the inspectors worked only in the day, there was a possibility that through carelessness a substitution, for example, of drop test pieces might occur before the inspector arrived in the morning. Under the "special" inspection both day and night supervision is established at all parts of the mill, and all of the operative mills in the country can now be covered in this way if a road ordering rails desires it. The normal force of special inspectors includes 97 men, divided approximately as follows: 20 open hearth furnace inspectors, 6 Bessemer furnace inspectors, 27 blooming mill inspectors, 23 rail mill inspectors and 21 drop test inspectors. The men at each mill are under the supervision of a chief inspector, who in many cases has a clerk and a well-equipped office.

This special service has now been in operation long enough to demonstrate many of its advantages, although, of course, it is too early to determine the final effect upon the wear and breakage of rails in the track. Any improvement in the quality of the rails which is effected by this inspection is not due to any change in the mixing, blowing, pouring or rolling, but to the careful watch which is kept on the minor details of these processes, with a view to eliminating any bad practices that may be adopted by employes to increase the output or to make the work easier for them. In general, the mill executives and superintendents are co-operating with the inspectors, as they appreciate the beneficial effect on their men of such an inspection. In reality these inspectors perform a service equivalent to that of additional foremen, although they have no direct authority over the employes in the mill.

A very common phrase in rail specifications covering the mill work is that the "manufacture of the steel and its subsequent treatment shall be according to the best current practice." This absence of definite clauses covering the processes of manufacture makes it very difficult to enforce any absolute rules, and the inspectors accomplish their purpose by suggestions to the men or the foremen and by reporting, both verbally and in writing, on any practices of which they do not approve. Such reports are generally so timed as to permit the mill to divert the steel or the rails to some other use in preference to having the evidence collected by the inspector presented to the road for which the rails are being rolled. A card record is started of each heat by the open hearth or Bessemer inspector, who turns it over to the blooming mill inspector after he has seen the ingots stripped. This man keeps up the record until the blooms are rolled and sheared, after which the rail inspector's duties begin. The drop test inspector also receives the card when the tests are to be made, so that a permanent and complete record of the manufacture and treatment of each heat of steel is provided.

A few examples of practices discovered and corrected by these inspectors will illustrate the possibilities of this system. During the blowing of several Bessemer heats the converters "spit" badly, obviously reducing the amount of metal contained. Without regard for this, however, the customary amount of recarburizer was added in each case, producing steel with high carbon and high manganese. A report on this occurrence resulted in the superintendent of the Bessemer department being disciplined, and he later left the company's employ. After an open hearth heat is tapped and most of it is in the ladle, the melter may suddenly decide that it is too low in carbon and add coal to the metal as it rises to the top of the ladle. Under favorable conditions the carbon will diffuse itself evenly throughout a heat, but when conditions are not the most favorable it is likely to segregate, and the chemical test might fail to show this segregation, although some of the rails would be adversely affected.

If an ingot is rolled very cold in the blooming mill the heater at the reheating furnaces may open up his furnace to its full capacity in order to heat the bloom a little quicker, with the result that the top corners become too hot, and if the top part of the bloom is rolled into the flange of the rail, a weak flange may result. While it may look all right, the quality will probably not be equal to that in the remainder of the rail section. The superintendents in some mills have watched the timing of the ingots in the soaking pits more carefully at the suggestion of the special inspectors, with the result that the ingots have been more evenly heated and better rolling secured. At a large mill where a number of heats are being cast at the same time, or where Bessemer and open hearth plants are using the same soaking pit, the heats may sometimes become mixed. In one instance 16 ingots were reported cast in one heat and the blooming mill inspector noticed that 17 were charged into the soaking pit. Investigation showed that one ingot from a 0.16 per cent carbon heat had been mixed with the high carbon ingots. If this ingot had been rolled, eight very soft rails would have resulted.

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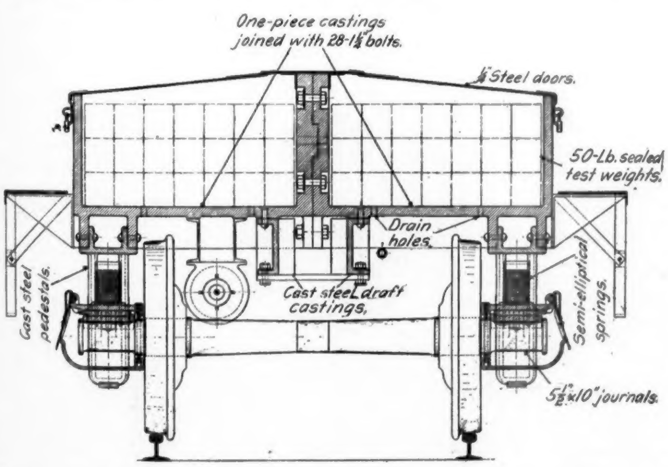
A NEW 80,000-LB. TRACK SCALE TESTING CAR

A new track scale testing car weighing 80,000 lb. has recently been designed by the Fairbanks Company, New York, superseding the 60,000-lb. car formerly made and used by this company. The old car, which was built up of structural steel, was not rigid enough for the heavy load which it carried, it required a great many test weights, as its tare weight was only 20,100 lb., and its total weight 60,000 lb. was hardly considered heavy enough for testing scales on which freight cars with a maximum weight of 80 tons are weighed. The new car has some additional advantages over the old one, which are brought out in the following description:

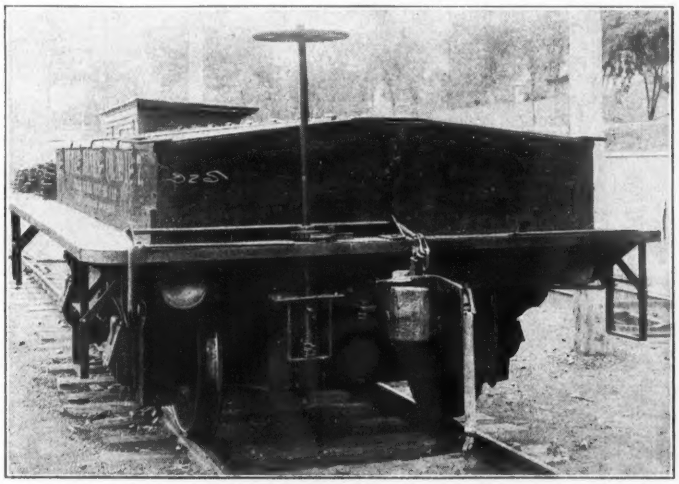
The car is of the rigid wheel base type with a cast iron body, having a total length of 14 ft. 11 in., a width over the platform of 9 ft. 10 in. and a wheel base of 7 ft. The car is designed to offer a very slight wind resistance, and its center of gravity is low, both of which are important features in securing an accurate test. The underframe, body and weight compartments are formed by two one-piece castings, accurately machined where they connect and provided with a recess and a projection to relieve the shear on the connecting bolts. They are connected by 28, 1¼-in. bolts, the nuts having spring washers to prevent their loosening due to the vibration of the car. Recesses are provided for the heads of the bolts and for the nuts in order to preserve straight surfaces inside the test weight compartments. The



Cross Section of Scale Testing Car, Showing Details of Construction.

castings have sockets at the corners to form push pole pockets. There are eight weight compartments, each 3 ft. 4½ in. by 3 ft. 2½ in., with drain holes in the bottom, each compartment being closed by a hinged door of ¼-in. steel plate opening toward the center of the car and held closed by a padlock.

The draft castings are of cast steel riveted to the main castings. The car is equipped with the Westinghouse friction draft gear, standard M. C. B. couplers and coupling device, Westinghouse air brakes and a hand brake, the wheel of which is arranged to be detached easily to allow the end compartment doors to be opened, cast steel journal pedestals riveted to the main body castings, semi-elliptical pedestal springs, M. C. B. standard journal boxes, bearings, axles and wheels. The car is provided with a platform extending around all sides which is 8 in. wide at the end and 14 in. wide at the sides. This platform is built up of ¼-in. checkered steel plates reinforced with angles on the edges and supported by pressed steel brackets attached to the main casting. A tool box is attached to the under side of the car which is built up of ¼-in. plates and steel angles, having a door on each side of the car and a sliding tray which provides a means for sealing the car to an exact weight. A ⅛-in. steel plate is attached to the under side of



A New Type of Scale Testing Car Weighing 80,000 lb.

the car and extended back to the tool box to prevent the accumulation of snow and ice on the projection under the car.

The car is designed to have a tare weight of as near 38,000 lb. as possible. This may vary within a few hundred pounds either way, but if it does, this weight may be adjusted by means of the tray mentioned above and the car sealed to the nearest 100 lb. It is designed to carry 42,000 lb. of 50-lb. test weights, making the total weight 80,000 lb. The object in having the test weights greater than the tare weight of the car, is to provide a means for verifying the weight of the car on any track scale in good working condition. The test weights used with this car are of high grade close grained cast iron arranged with a pipe handle which furnishes a ready means for handling and also contains the sealing material. This is held in position inside the pipe by a screwed plug which is sealed by means of a lead cap forced into a dove-tailed recess, thereby furnishing evidence that the weight has not been tampered with after final sealing. The weights are painted with a special non-absorbent paint, which prevents as far as possible the absorption of moisture. While the government tolerance of these 50-lb. weights is 20 grains, the weights with which this car is equipped are sealed to a tolerance of 2 grains.

FOUR-CYCLE GASOLINE ENGINE FOR HAND OR PUSH CARS

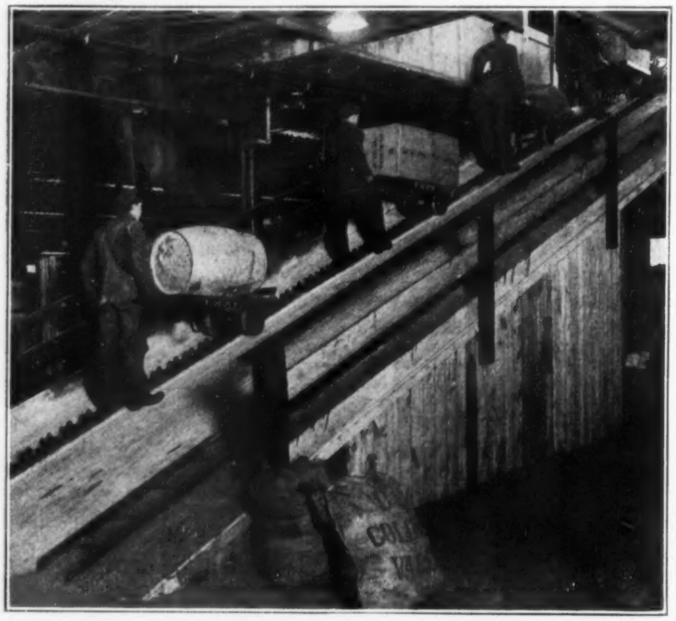
The Kalamazoo Railway Supply Company, Kalamazoo, Mich., has recently produced a new gasoline engine of the two-cylinder, four-cycle type designed especially for application to hand or push cars. The principal features of this motor are similar to those used in the engine of the No. 30 car which has been in satisfactory use for some time, the principal change being in the mounting of this engine on a sub-base. It is built up as a complete unit with the gasoline tank rigidly attached to the top of the crank case and carrying the control levers for the spark and throttle. It

can be equipped either with a pulley or chain and sprocket drive, the engine sliding on its sub-base to tighten the belt in the former case. When a chain drive is used a friction clutch is furnished for application to the drive axle.

The engine is air-cooled and reversible. The cylinder has a 4-in. bore and a 6-in. stroke. It is lubricated by forced feed lubrication, the crank shaft and connecting rod being lubricated by a combined splash and ring bearing lubrication. The engine uses either magneto or battery ignition and is equipped with a heavy fly-wheel having fan blades for spokes. It normally develops about 8 hp. The company can also furnish this engine applied to a motor car in which case it is known as the No. 50 car.

INCLINED ELEVATOR FOR FREIGHT HOUSES AND DOCKS

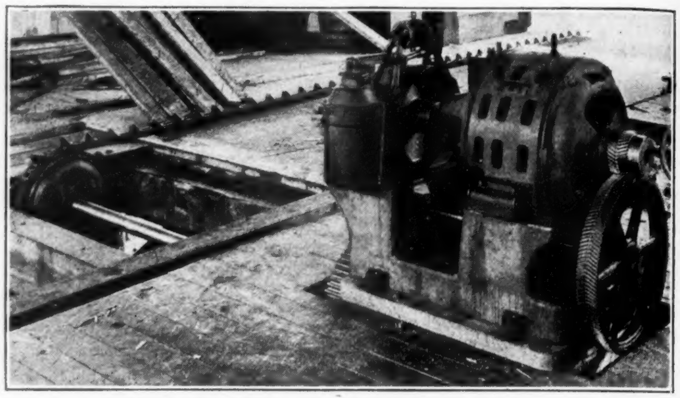
The Pere Marquette has recently installed an inclined elevator in its terminal warehouse at Third and Congress streets, Detroit, Mich., similar to those which have been successfully used for some time at docks along the seaboard for handling freight between the warehouse and



Handling Freight to the Upper Warehouse Floor of the Pere Marquette Station in Detroit on an Inclined Elevator.

vessels. The construction of this elevator, which consists briefly of a moving ramp and an endless chain with lugs which engage the axles of the ordinary two-wheeled trucks was described in the Railway Age Gazette of April 11, 1913. The elevator in the Pere Marquette house is arranged to operate either up or down and has replaced three hydraulic elevators with platforms approximately 10 ft. by 10 ft., having a capacity of 4,000 lb. at a speed of 50 ft. per minute. This elevator handles all of the overflow of the incoming freight from the first to the second story of the warehouse. By its use the freight can be removed from the car directly to its place of storage on the upper floor without transferring the load.

While it is too early to determine the exact economy effected in the Detroit installation, the experience previously gained with these elevators indicates that such economies can be effected. For instance, at the Weehawken docks of the New York Central it is reported that the labor cost with these machines is reduced from two to three cents per ton, and the time of unloading lighters is decreased by an amount equivalent to increasing the capacity of the marine equipment from 20 to 40 per cent, depending upon conditions. At the New York and Norfolk terminals of the Old Dominion Steamship Company the inclined elevators are reported to save the labor of four longshoremen for periods of approximately five hours per day. The Merchants & Miners Transportation Company, which has two of these machines at its Savannah, Ga., terminal, four at its Mystic Wharf terminal in Boston, and

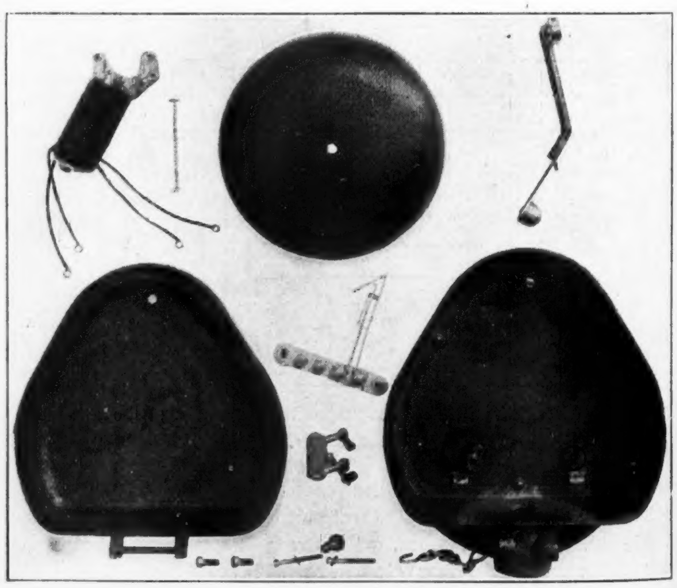


The Operating and Control Apparatus of the Inclined Elevator at the New York Central Dock at Weehawken, N. J.

six at its new city terminal in South Boston, estimates savings of 13 to 15 per cent in the cost of handling freight by the use of these elevators. At another installation it has been stated that the inclined elevators save nine cents in the cost of transferring a ton of freight, the cost of power in this case being about $0.001 per ton.

DIRECT CURRENT CROSSING BELL

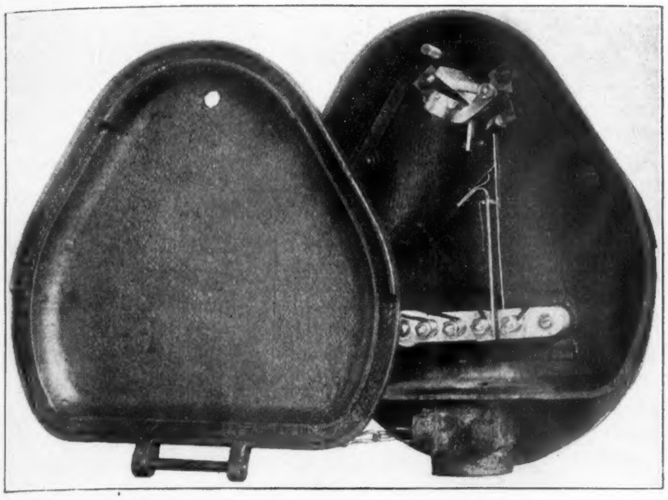
The Union Switch & Signal Company, Swissvale, Pa., has developed a new design of d. c. crossing bell which complies with R. S. A. specifications throughout, and in which the most notable feature is simplicity. Coils and contacts are readily removed or replaced without disturbing or changing the adjustment of other parts of the mechanism, and the operating mechanism may be readily exposed for inspection



Direct Current Crossing Bell Details.

without the removal of the gong or in any way interfering with the operation of the bell.

The coils are wound to 10 ohms resistance for a normal operating battery of 6 volts. The bell, however, will operate satisfactorily on less than 4 volts. Special features are the removable arcing tips which protect the circuit controller



Direct Current Crossing Bell, Complete.

contacts from injury, and a simple circuit controller adjustment which permits the contact opening to be varied without bending the springs or loosening the terminal posts.

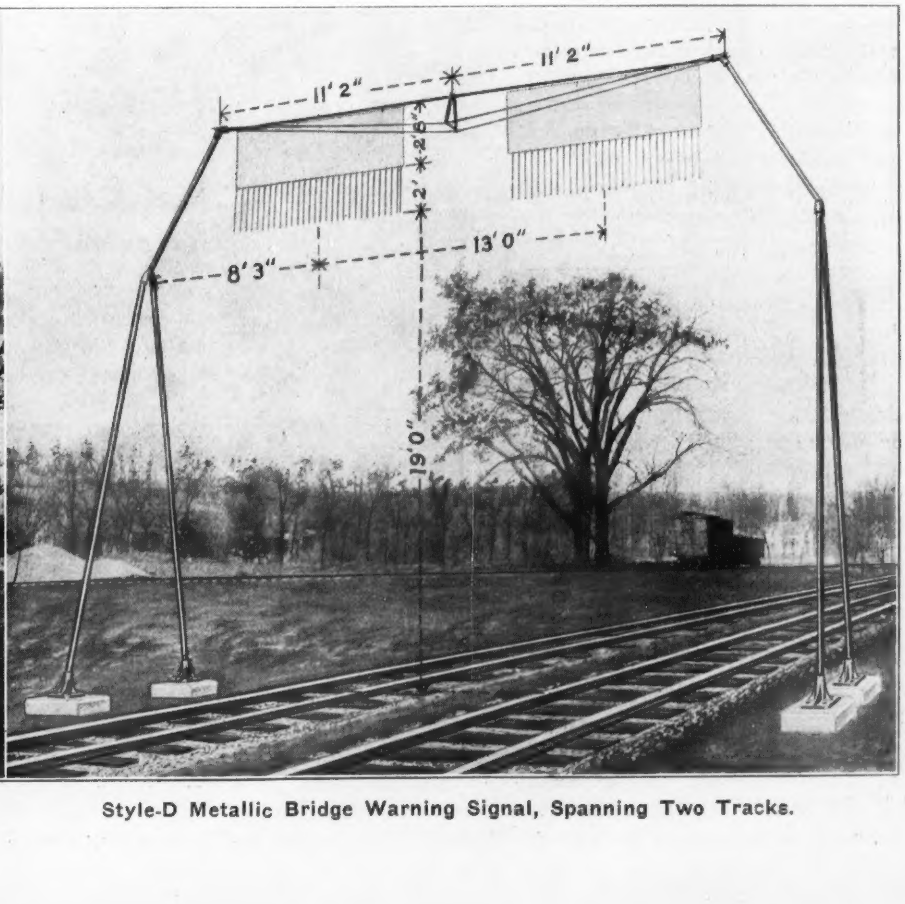
TWO NEW TYPES OF BRIDGE WARNING SIGNALS

The Chicago Railway Signal & Supply Company, Chicago, has recently placed on the market two new styles of bridge warning signals which use the same form of screen and "tickler" cords but differ in the design of the supporting structure. The style A signal shown at the left in the accompanying illustration is a single-track warning made of heavy steel pipe so arranged that the cross arm can be folded down out of the way when necessary. To accomplish this purpose the horizontal pipe is counterweighted on one end and is stiffened by a truss rod and an anchor rod connecting it to the vertical post. The wire screen is 8 ft. long and 2 ft. 8 in. deep, being made of extra heavy wire with 1-in. mesh connected to an endless rim. The screen serves to keep the cords in position at all times and is supported from the horizontal pipe by closed hook bolts which allow it to be swung without danger of unhooking. The cords are chemically treated to increase their life. They are wired to the screen and their lower ends are wound with marline to prevent fraying. Unless otherwise specified, this warning is furnished with a clearance of 21 ft. to the bottom of the screen and 8 ft. from the near rail to the supporting pole. Sufficient cord, wire and marline are furnished for 33 drop cords, each 24 to 36 in. long.

The same type of warning signal is furnished for spanning two to ten tracks, the only differences in construction being that the screens are supported by a heavy galvanized steel cable on which they are hung by galvanized slip links and are held in place laterally by flexible galvanized wire rope, the ends of which are left long to allow the screens to be pulled to either side without removing them from the supporting cable. Each pole is anchored by two steel guy rods equipped with long turnbuckles which permit of adjustment and alinement of the signals and with anchor rods having an anchor plate and nut suitable for fastening to the foundation and on the other end an eye for attaching to the guy rods. The interchangeability of the parts of the single and multiple track warnings make it possible to utilize a single track signal when additional tracks are built by erecting a second supporting pole and substituting the cable for the cross pipes. For warnings spanning from 3 to 10 tracks, heavier and longer poles are used with a curved messenger cable above the supporting cable to strengthen the construction.

The style D warning of which the double-track form is shown at the right in the accompanying illustration, is also of metallic construction throughout using the same screen and cords described above. Unless otherwise specified these warnings are made with a clearance of 19 ft. below the lower ends of the tickler cords and 8 ft. 3 in. from the center line of the track to the supporting posts. The cords are usually furnished 2 ft. long but can be made any desired

Single-Track, Style-A Chicago Bridge Warning.

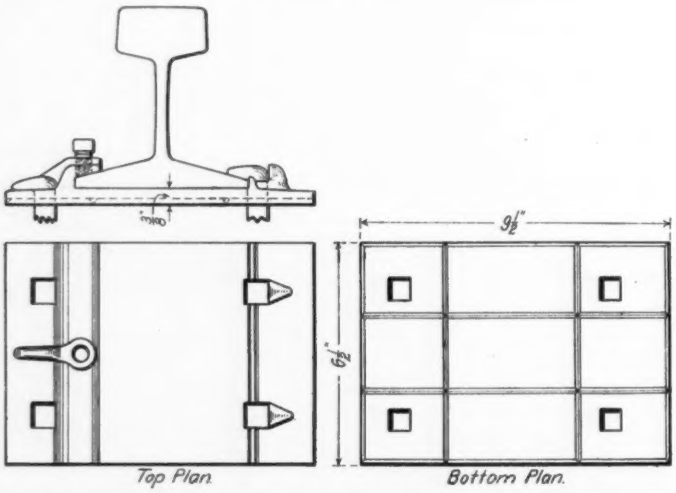


Style-D Metallic Bridge Warning Signal, Spanning Two Tracks.

length. The screens are hung directly from the top supporting pipe by closed hook bolts, the truss rods shown in the illustration being omitted in the single-track warning. These warnings are assembled complete at the company's plant before shipment and can be erected in the field without fitting, threading or pipe cutting. Each of the supporting pipes is equipped with a base casting which is calked to the pipe before shipment and is accompanied by the necessary anchor bolts for attaching to the foundation. The warnings of these types in the standard dimensions illustrated are being kept in stock to allow immediate shipment.

THE THOMAS RAIL ANCHOR TIE PLATE

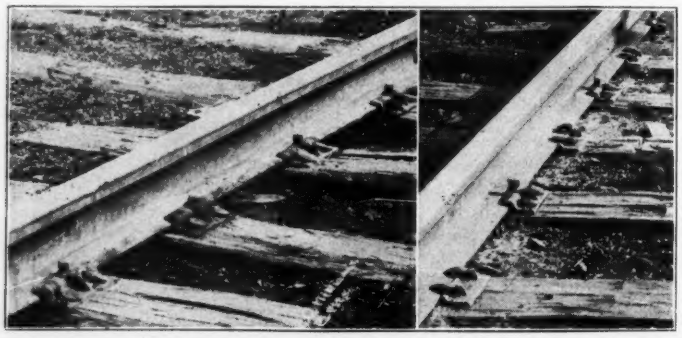
The Thomas rail anchor tie plate has been in use on the Kansas City Terminal for the past four years, is now installed on a curve and a turnout of the Union Pacific in Kansas City and is being tested by a number of other roads. This device



Section and Plans of the Thomas Rail Anchor Tie Plate.

consists of a plate 6½ in. by 9½ in. by ⅜ in., with a shoulder along each edge of the rail base, a lug back of each inside spike hole to heel in the spikes and a rib on the outside edge of the plate extending up over the shoulder, through which is placed a ⅝-in. diameter set screw bearing against the upper surface of the rail base. The under side of the plate has small corrugations at right angles to the edges.

The edges of the plates are strengthened against buckling or breaking by the shoulders, lugs and rib and the rail is



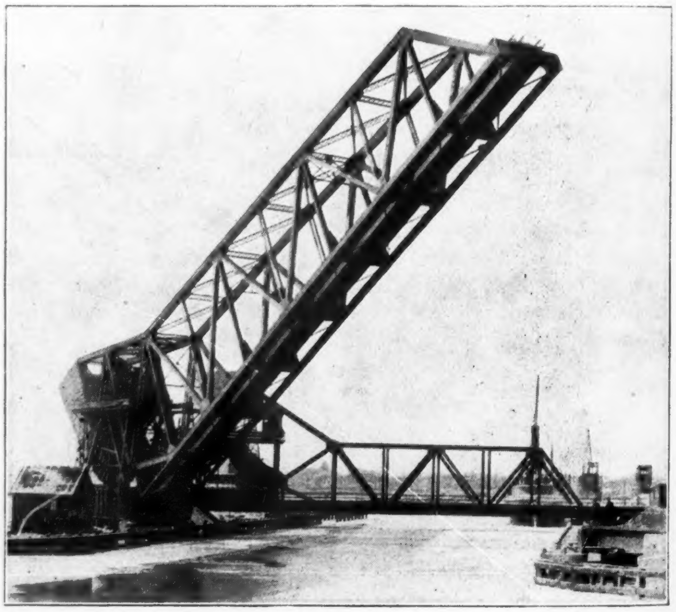
Two Views of the Rail Anchor Tie Plate in Track, One Showing the Plates Reversed on Alternate Ties.

retarded from creeping by the grip of the set screw and the friction of the outside overhanging shoulder and the inside spike. This anti-creeping feature is operative for traffic in either direction. The set screw is cup-pointed and made of tempered steel. It is inserted perpendicularly and when screwed down against the rail the threads of the screw become meshed forming a lock which prevents it from loosening. One engineer maintenance of way reports that he has noticed that within three or four months the set screws become rusted sufficiently to make them immovable to any pounding by traffic. In the Kansas City Terminal test the set screws are said to have remained tight for the entire four years. In addition to the action of this device as a tie plate and rail anchor one general roadmaster who has tested it finds that by reversing the plates on alternate ties they can be used on sharp curves to prevent the rails from turning and spreading.

The rail anchor tie plate is made from the best grade of Bessemer and charcoal malleable iron, each cast being analyzed in the laboratory and each heat subjected to physical test. These plates are manufactured by the Chicago Malleable Castings Company, West Pullman, Chicago, Ill.

TWO SCHERZER ROLLING LIFT BRIDGES FOR THE DELRAY CONNECTING RAILROAD

The Solvay Process Company, in making general improvements on its subsidiary railroad, the Delray Connecting, found that it would be advisable to replace a center pier swing bridge, over the River Rouge at Detroit, Mich., with



Two Scherzer Rolling Lift Bridges Operated from One Controller House.

Scherzer rolling lift bridges to facilitate the increasing traffic between the company's plant and the railway yard. The government requires a 120-ft. clear opening between fenders on this river, and as the two bridges were to be within 150 ft. of each other, plans were approved for two single-track rolling lift bridges at diverging angles from the south bank.

The east bridge has a movable span of 210 ft., a track girder span of 40 ft. on the south bank and an approach span of 20 ft. on the north end, while the west bridge has a movable span of 141 ft., a track girder span on the south of 34 ft. and an approach girder span of 20 ft. at the north end. Both bridges are designed for Cooper's E-60 loading and under the American Railway Engineering Association specifications. In addition to the railway traffic, the short span is used by highway bridge and has 4-ft. sidewalks carried on brackets on the outside of the trusses. A roadway of 15 ft. between curbs and 26 ft. 5 in. between sidewalk railings is provided. The movable span is of the Warren through truss type, 16 ft. 3 in. center to center of trusses with parallel chords 29 ft. center to center. The span is equipped with a 37-hp. a. c. motor and

with means for operating by hand when desired. It operates through an angle of 81 deg. 10 min. The 210-ft. span has the same general details with the following exceptions: It is strictly a railway bridge with trusses 18 ft. center to center and a sloping top chord. The bridge is operated through an angle of 76 deg. 23 min. and is equipped with two 30-hp. a. c. motors and also with means for operating by hand. Both bridges are operated from one house, which is supported on brackets on the west side of the track girder span of the long bridge. Each has a separate control and one operator can move them together or separately as desired.

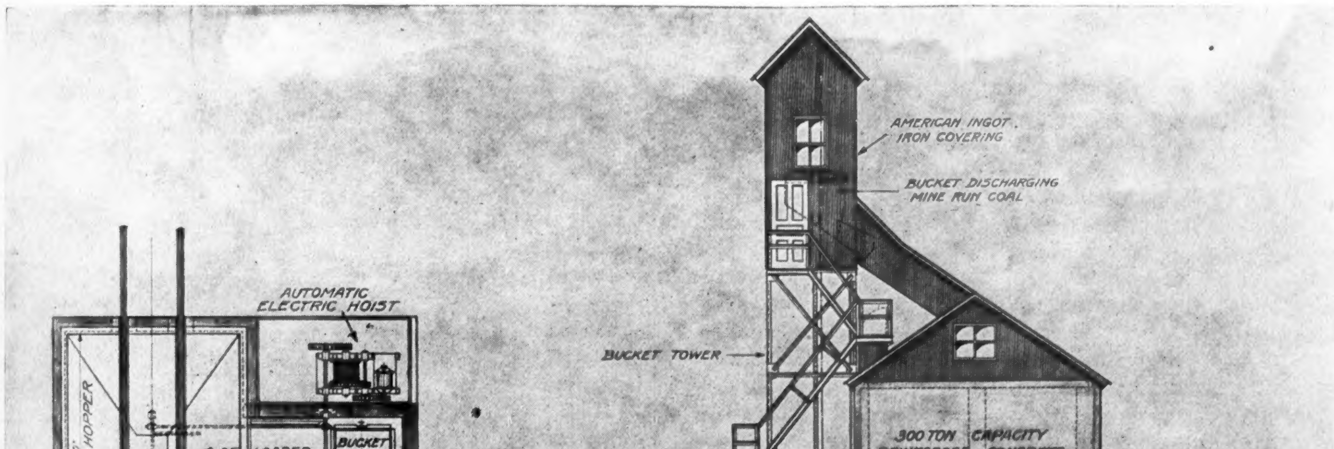
Rapid progress was made on both of these bridges. On the longer one, the first steel was raised on May 20, 1914, erection was completed on July 19, the bridge was operated on July 27 and on August 15 it was opened to traffic. On the 141-ft. span erection was started on October 6 and was completed on November 7, the bridge was operated November 14 and traffic was placed on it December 3.

The Scherzer Rolling Lift Bridge Company, Chicago, furnished the designs, plans and specifications of the superstructure, operating machinery and power equipment for these bridges and also maintained a consulting engineering supervision during the manufacture and erection. The engineering department of the Solvay Process Company designed the substructures. The Pennsylvania Steel Company manufactured and erected the superstructures and Messrs. Ginzel and Towler, Detroit, Mich., were the contractors for the substructures.

A SHALLOW PIT LOADER FOR A COALING STATION

A new type of pit loader for use at locomotive coaling stations that requires a depth of pit of only 12 ft. has recently been designed by the Roberts & Schaefer Company, Chicago. This loader is intended for use with the "Holmen" type of elevating bucket, which is also installed by this company. The loader consists of a large, heavy steel receptacle with a capacity of 2½ tons of mine-run coal which operates on an inclined track of heavy channels from its unloading position under the track hopper to its dumping position over the elevating bucket. A continuous roller guide is provided for the loader discharge apron to keep it positively in the closed position except when loading the elevating bucket. A ¾-in. steel undercut gate mounted on rollers controls the flow of coal from the receiving hopper and is actuated by the traveling loader.

The loader is operated by an automatic electric hoist which also controls the elevating bucket. This hoist has a diffen-



A Holmen Coaling Station Equipped with 12-ft. Bucket Pit. Loader Filled, Gate Open and Elevating Bucket Discharging at Left, and Bucket Loading with Hopper Closed at Right.

tial action with a ratio of travel of 7:1 for the pit loader and the coal elevating bucket. The loader is geared directly to the hoist. The entire equipment, being automatic, is under the control of the operator in the hoist house by means of an electric push button.

A COMPARISON OF TITANIUM TREATED AND STANDARD OPEN-HEARTH RAILS

In bulletin No. 170 of the American Railway Engineering Association dated October, 1914, there appears a report by M. H. Wickhorst, engineer of tests of the Rail Committee on "The Influence of Carbon on the Properties of Rail." This report covers an extended series of tests made at the plants of the Carnegie Steel Company and the Maryland Steel Company. The blooms from which these rails were rolled were selected from stock and no effort was made to locate the position of each rail in the original ingot. It is fair to assume, therefore, that these samples were in general representative of the average run of steel rails of approximately the same analyses as reported.

In Mr. Wickhorst's report he presented a formula for the tensile or ultimate strength

$$T = 40{,}500 + 1{,}250\ C$$

T being the tensile strength in pounds per square inch and C being the amount of carbon in 0.01 per cent.

Mr. Wickhorst states that, "this is for open-hearth steel with about 0.03 per cent phosphorus and about 0.70 per cent. manganese in test specimens of ½-in. diameter and 2-in. gage length and between limits of 0.30 and 0.80 per cent carbon."

On another page he presented a formula for the calculation of elongation as related to the tensile strength

$$E = 52 - \frac{T}{3300}$$

He stated that, "this formula applies for tensile strength of 80,000 to 130,000 lb. per sq. in. It gives the average elongation and individual results may fall above or below this average."

Previous to the appearance of this report the Titanium Alloy Manufacturing Company, Niagara Falls, N. Y., had issued seven bulletins covering detailed studies of 17 standard and 17 Titanium treated open-hearth rails.

Following the appearance of the A. R. E. A. report the Titanium Alloy Manufacturing Company applied these formulæ to the results secured in the tests reported in their bulletin. On two of the samples of each set chemical analyses were not taken from points identical with those from which the tensile test specimen pieces were taken and it was therefore possible to make a comparison on only 15 of the 17 samples of each class of rails.

The accompanying table shows the results of this comparison, samples 6 and 7 of each class being omitted for the reasons just stated. Columns 2 to 6 inclusive, show the analyses of carbon, manganese, phosphorus, sulphur and silicon, respectively, in the center of the head of each sample. Column No. 7 shows the theoretical tensile strength calculated by Mr. Wickhorst's proposed formula. Column No. 8 shows the actual tensile strengths of the various samples as reported in the manufacturer's bulletins. Column No. 9 shows the theoretical elongations according to Mr. Wickhorst's formula, while column No. 10 shows the actual elongations as previously reported in the bulletins. Column No. 11 shows the percentage of the actual to the theoretical ultimate strength while column No. 12 shows the percentage of the actual elongations to the theoretical. The last column shows the "merit" of the various specimens obtained by multiplying the percentage figures in column 11 by those in column 12.

From this comparison it is seen that the average ultimate strength of the Titanium-treated rails is 95 per cent, of the theoretical strength computed by the Wickhorst formula as compared with 90 per cent. for the untreated rails while the Titanium-treated rails showed an average elongation of 98 per cent. of that computed by the formula as compared with 83 per cent. with the untreated rails. The average "merit" for the Titanium-treated rails is seen to be 94 per cent. as compared with 75 per cent. for the untreated rails, or over 20 per cent. greater. As the amount of Titanium remaining in the steel is very slight, these results would indicate that the logical explanation for this improvement lies in the greater uniformity of the treated steel.

COMPARISON OF SAMPLES FROM 15 UNTREATED OPEN HEARTH A-RAILS AND 15 TITANIUM TREATED OPEN HEARTH A-RAILS AS REPORTED IN OUR BULLETINS 1 TO 7 INCLUSIVE, AND SUMMARIZED ON PAGES 4 AND 5 OF BULLETIN No. 7.

Standard Open Hearth A-Rails		C	Mn	P	S	Si	Theoretical Wt. Str.	Actual Wt. Str.	Theoretical Elongation	Actual	Percentage Actual to Theoretical		
										Elongation	Ultimate Strength	Elongation	Merit
Untreated	1	.74	.682	.025	.028	.170	133,000	122,700	14.9	9.5	92%	64%	59%
	2	.75	.901	.026	.050	.145	134,250	122,100	15.0	8.5	91%	57%	52%
	3	.85	.816	.026	.049	.120	146,750	115,700	17.0	4.0	79%	24%	19%
	4	.71	.584	.019	.035	.109	129,250	116,200	16.8	14.0	90%	83%	75%
	5	.88	.770	.028	.041	.160	150,500	120,900	15.4	4.5	80%	29%	23%
	8	.75	.811	.023	.055	.140	134,250	125,600	14.0	15.8	94%	113%	105%
	9	.74	.857	.020	.040	.160	133,000	124,900	14.2	15.8	94%	111%	104%
	10	.82	.943	.027	.027	.106	143,000	119,800	15.7	16.5	84%	105%	88%
	11	.71	.859	.025	.045	.113	129,250	117,700	16.4	18.0	91%	110%	100%
	12	.72	.882	.029	.052	.100	130,500	119,100	16.0	18.0	91%	113%	103%
	13	.73	.588	.020	.112	.192	131,750	129,900	12.7	9.5	99%	75%	74%
	14	.82	.594	.018	.056	.070	143,000	141,400	9.2	7.5	99%	82%	81%
	15	.73	.827	.018	.021	.107	131,750	121,800	15.1	14.3	92%	95%	88%
	16	.54	.541	.015	.028	.053	108,000	98,700	22.1	22.3	91%	101%	92%
	17	.64	.530	.013	.026	.062	120,500	99,400	21.9	16.8	82%	77%	63%
Averages		.74	.745	.022	.044	.120	133,250	119,726	15.7	13.0	90%	83%	75%
Titanium-Treated	1	.70	.735	.024	.024	.110	128,000	121,000	15.4	14.3	95%	93%	88%
	2	.77	.810	.018	.035	.092	136,750	125,000	14.2	9.5	91%	67%	61%
	3	.83	.784	.018	.034	.130	144,250	127,100	13.5	13.0	88%	96%	85%
	4	.64	.646	.016	.030	.075	120,500	115,800	17.0	13.3	96%	78%	75%
	5	.77	.764	.029	.039	.100	136,750	124,500	14.3	13.0	91%	91%	83%
	8	.73	1.040	.026	.027	.080	131,750	128,200	12.6	16.8	97%	133%	130%
	9	.67	.776	.025	.031	.094	124,250	120,700	15.5	18.8	97%	121%	117%
	10	.74	.904	.023	.043	.094	133,000	125,700	14.0	16.8	95%	120%	113%
	11	.75	.943	.039	.043	.122	134,250	133,500	11.6	13.5	99%	116%	116%
	12	.75	.815	.018	.034	.108	134,250	124,000	14.5	15.0	92%	103%	95%
	13	.74	.578	.011	.050	.066	133,000	132,600	11.9	12.0	100%	101%	100%
	14	.79	.615	.016	.063	.056	139,250	140,900	9.6	11.5	101%	120%	121%
	15	.77	.735	.023	.028	.103	136,750	125,500	14.0	11.8	92%	84%	77%
	16	.71	.652	.024	.026	.056	129,250	122,000	15.1	11.5	94%	76%	72%
	17	.73	.828	.021	.030	.086	131,750	126,600	14.0	14.0	96%	102%	98%
Averages		.74	.775	.022	.036	.091	132,916	126,206	13.8	13.6	95%	98%	94%